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EDITIORAL INDEX PAGE—77 ADVERTISING INDEX PAGE—78

THE POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.
Published by The MacLean Publishing Co., Limited.
MONTREAL: Eastern Townships Bank Bldg. TORONTO: 143-153 University Ave. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 22 Royal Bank Bldg
Vol. X Publication Office, Toronto—January, 1917 No. 1

GLOBE

TRADE PENBERTHY MARK

BRASS VALVES

We make both types, viz.:

REGRINDING *(With the Metal Disc)*

COMPODISK *(With the Composition Disc)*

REGISTERED AND APPROVED

ANGLE

HORIZONTAL

SWING

THE QUALITY IS ALWAYS HIGHER THAN THE PRICE

No Other Valve

on the market is as pleasing in appearance, perfect in workmanship, or as satisfactory in service. Among our many customers are leading and conservative manufacturers and jobbers throughout the country, who demand the best for their money—and get it here.

Are you looking for a better valve? Take time to investigate carefully. You will not regret it.

Penberthy Injector Co., Limited, Windsor, Ontario

Makers of All Quality Brass Valves

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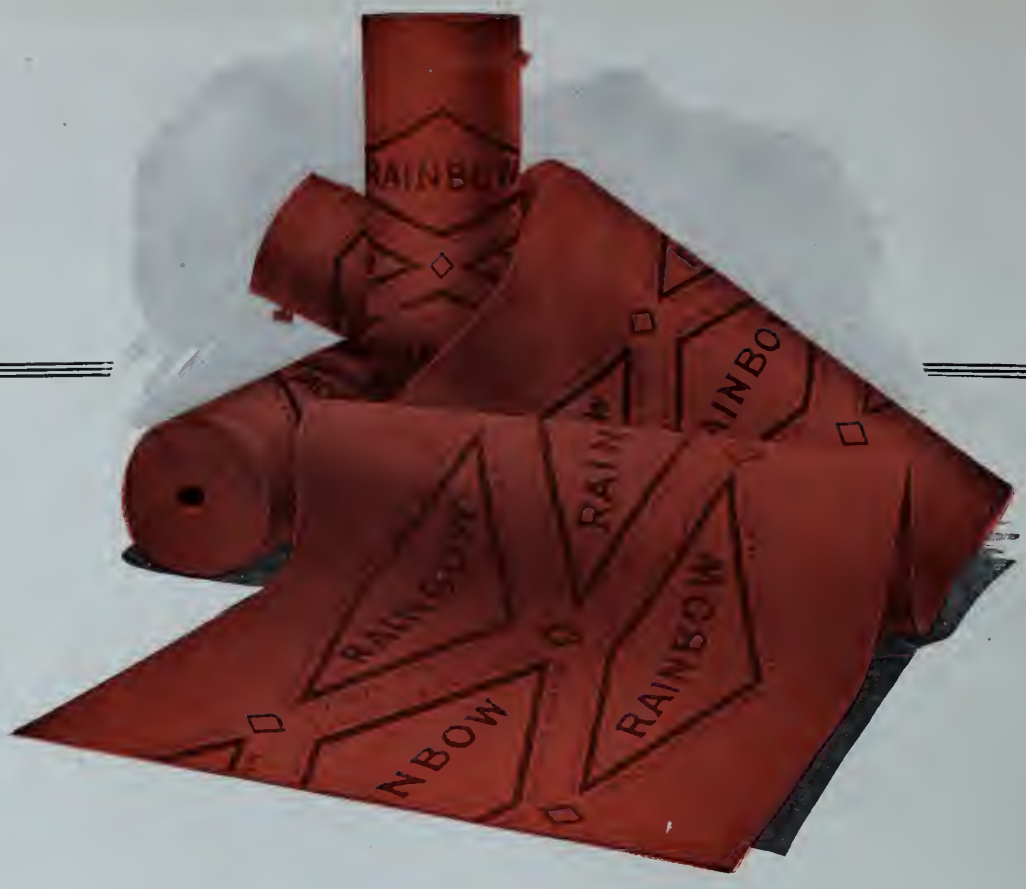

RAINBOW RED SHEET

GIVES BETTER RESULTS AND LASTS LONGER THAN ANY PACKING MADE.

YOU ARE SECURE FROM "BLOW-OUTS" AND "SHUT-DOWNS" WITH RAINBOW ON THE JOB.

TRY IT ON THE NEXT JOINT YOU PACK.

Peerless Rubber Mfg. Co.

31 Warren Street, New York

Canadian Representatives: CANADIAN ASBESTOS CO., Montreal

WATEROUS

"EVERYTHING FOR THE POWER PLANT"

Waterous Boilers built in Vertical, Horizontal and Portable types, have been the standard of goodness in Canadian power plants for more than 50 years.

Ask for Bulletins.

Steel Plate Work

Before you buy anything in Steel Plate Work, send us your sketches and let us quote prices and delivery.

We specialize in turning out difficult work of this kind, built right.

Recent extensions to our shops, new equipment, a competent and experienced staff are at your service. If your job presents special difficulties, we will solve them for you.

We design and build any size, any kind of

Pressure Tanks
Storage Bins
Steel Buckets
Refuse Burners
Steel Stacks
Smoke Breechings
Riveted Steel Pipe
Cookers and Digesters
Conveyers and Elevators

We make a specialty of tanks of extra large size. Any work of this kind that you cannot buy elsewhere you can obtain at reasonable prices from our shops.

The Waterous Engine Works Co., Ltd., Brantford, Can.

Hoyt "Frost King" Babbitt Metal will prove an ideal medium between you and trouble. Forty years' experience has enabled us to give you a babbitt metal that will give extraordinary results for all classes stationary engines, pumps, rolling mills, pulp machinery and planing mills. It "stands up."

This "Nickle Genuine" is especially designed for heavy duty mining machinery, and will give the utmost satisfaction. There is one thing that is absolutely positive about this alloy and that is, it is always uniform, not only to-day, but next year and ten years from to-day.

Hoyt Metal Company

Eastern Ave. and Lewis Street
Toronto Ontario Canada

London, England
New York, N.Y.
St. Louis, - Mo.

Jenckes Boilers

Vertical Tubular
Horizontal Tubular
Locomotive Types
Heating Boilers

The Jenckes Machine Co., Limited

SHERBROOKE - MONTREAL
ST. CATHARINES - TORONTO
COBALT - SOUTH PORCUPINE
NELSON - VANCOUVER

Works:
Sherbrooke, Que.
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We have on hand a large assortment of plates and tubes.

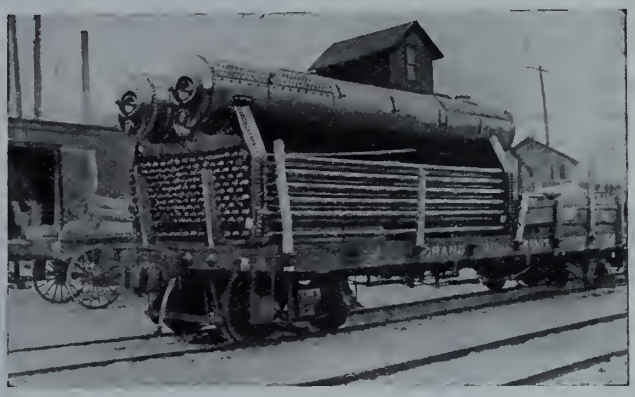
Prompt shipment of Standard Boilers, subject to prior sale.

Enquiries invited. Quick action may avert disappointment.

We Build :

WATER TUBE BOILERS like this

HORIZONTAL RETURN TUBULAR BOILERS
Standard or Special like this



And ALL KINDS OF TANKS like this

Also all kinds of Marine Boilers, Land Boilers, Plate Work, etc.

Send us your specifications and blue prints.

POLSON IRON WORKS, LIMITED

SHIPBUILDERS, ENGINEERS AND BOILER MAKERS

TORONTO, ONTARIO

SMOKELESS COMBUSTION + EFFICIENCY =

GALT SPRINKLER STOKERS

Ask for our New 40 Page Illustrated Catalogue.

The Galt Foundry Co., Galt, Ontario

ALBERTA
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Campbell Steel and Iron Works, Ltd.

THOMAS ELLIPTIC GRATE BARS—

SHAKING
CIRCLE
STATIONARY

Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

Murphy AUTOMATIC Furnace

January 1st, 1916, to October 1st, 1916

REPEAT ORDERS

from 45 leading industrial firms and corporations

One was 6th order—after 23 years' experience; a total of 11 furnaces—2,300 nominal H.P.

An 18th order from a corporation—after 19 years' experience with Murphy furnaces; the 18 contracts cover **136 Murphys**—82 of which are installed with boilers 25,500 nominal H.P.

Eleven repeat orders were from Canadian Customers!

There must be a reason!

For printed matter address

MURPHY IRON WORKS, BUFFALO, N. Y.
DETROIT, MICH.

'96

REG. U.S. PAT. OFF.
TRADE JENKINS MARK
Jenkins Bros

"As lasting as the flanges which hold it."

Jenkins '96 should be used on your steam, hot or cold water, air and other lines, because of its complete dependability for tightness and long service.

It is a high-grade, unvulcanized sheet packing of great strength and flexibility. On steam lines it is self-vulcanizing, forming a joint that will hold under the hardest service. If the gasket is dipped in graphite or soap stone before insertion, it will not cling to the pipe and may be easily removed and used over again indefinitely.

Your regular dealer can promptly supply Jenkins '96 in the usual thicknesses, as well as standard and special cut gaskets.

Write us direct for the No. 8 Jenkins Bros. Catalogue.

JENKINS BROS. Limited

103 St. Remi Street **MONTREAL**

PEILER'S SERVICE—

THE simple matter of buying goods at one price and selling at another never made a successful business. The ***Element of Service*** is what adds permanence to any organization, and the success of such organization is measured only by its ability to serve. The factor of ***SERVICE***—to the customer—always has been, and is, what has guided us in making connections with manufacturers of power plant specialties.

WE have had many years' experience solving difficult power plant questions, of all kinds and conditions, and the benefit of this experience is yours in dealing with us. If your conditions are not suitable for equipment supplied by us, we do not hesitate to advise what we think will overcome your difficulties.

ON this, and the opposite page, a few of our lines are shown. In our opinion, after long experience, with many tests and trials, they are the best, will stand up the longest, and give the most efficient service, of any that are made on the continent.

H. L. Peiler & Co.
311 Kent Building, Toronto, Ont.
380 St. James St., Montreal, Que.

We solicit your enquiries.

Bundy Steam Traps

When you get heat into water, keep it there! Keep it there and hold it there as long as possible, no matter where the water goes. This is the idea which the makers of the

BUNDY STEAM TRAPS

have been driving home to power plant men for years.

BUNDY STEAM TRAPS
combine Power, Simplicity and Efficiency

Nashua Machine Company
Manufacturers
Nashua - New Hampshire

H. L. PEILER & CO.
380 St. James Street - - Montreal
Are Our Agents in Canada

MASON
Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

CANADIAN AGENTS
H. L. PEILER & CO., MONTREAL and TORONTO

WHY put in another boiler

WHEN you can increase your present steaming capacity to 200 and in connection with stokers even 300% of the normal rating of the boilers without injury to the boilers by installing a

COPPUS TURBO BLOWER

You will have all the steam you want all the time. Hundreds of satisfied customers will attest to this. No drop in steam pressure when a heavy load comes on and you can laugh at the weather man, as you can dispense with him for your draft. Besides, the blower will pay for itself in a short time, as it will burn cheaper fuel.
Cut out this Ad., put your name and address on the margin, and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

in boilers equipped with Coppus Turbo Blowers in four years.
The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company
167 Union Street, Worcester, Mass.
Agents for Montreal—H. L. Peiler & Co., Montreal and Toronto.
Agents for Ontario—The Power Plant Equipment Co., Toronto, Ont.

Engineers with long experience will tell you that

Homestead Guaranteed Valves

are the best for all Water, Air or Steam Lines

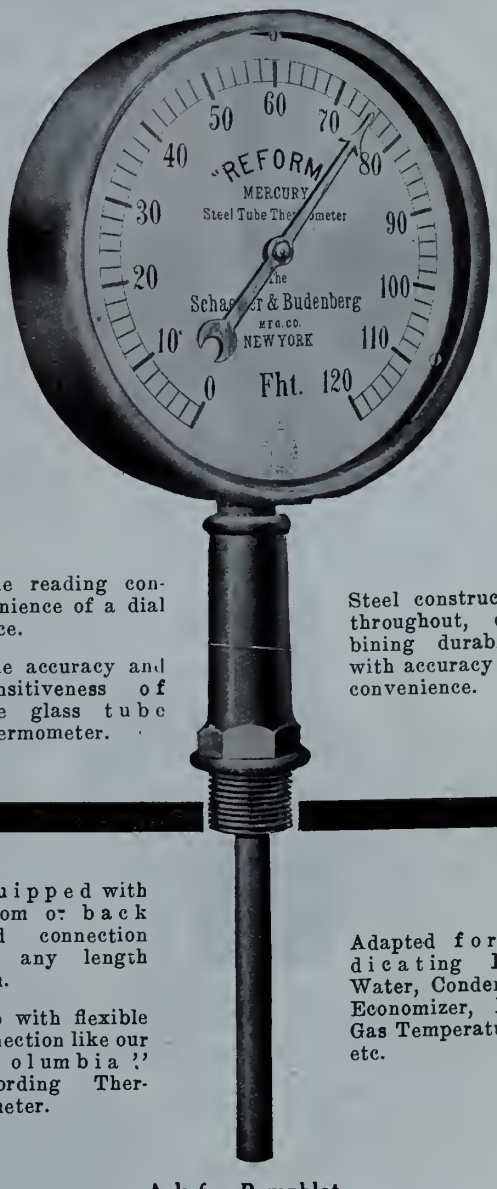
Simple in construction, easy to operate, and the only valve which will successfully stand up under the heaviest duty service. Made in Straightway, Threeway and Fourway patterns. Special valves for special purposes.
There's a Homestead Valve for every purpose.

HOMESTEAD VALVE MFG. CO.
PITTSBURGH - - PENNA.

Works: Homestead, Penna.

Our new circular, describing the Homestead in detail, is ready for you. Drop a card to-day for your copy.

"REFORM" Mercury Actuated Dial Thermometer



The reading convenience of a dial face.

The accuracy and sensitiveness of the glass tube thermometer.

Steel construction throughout, combining durability with accuracy and convenience.

Equipped with bottom or back rigid connection and any length stem.

Also with flexible connection like our "Columbia" Recording Thermometer.

Adapted for indicating Feed Water, Condenser, Economizer, Flue Gas Temperatures, etc.

Ask for Pamphlet W-101

THE Schaeffer & Budenberg MFG. CO.

Makers of "Columbia" Recorders, "Crescent" Thermometers, S & B Gauges, Tachometers, Counters, Calorimeters, Indicators, etc.

Berry and South 5th Streets, Brooklyn, N. Y.
Also Chicago, Philadelphia, Pittsburgh.

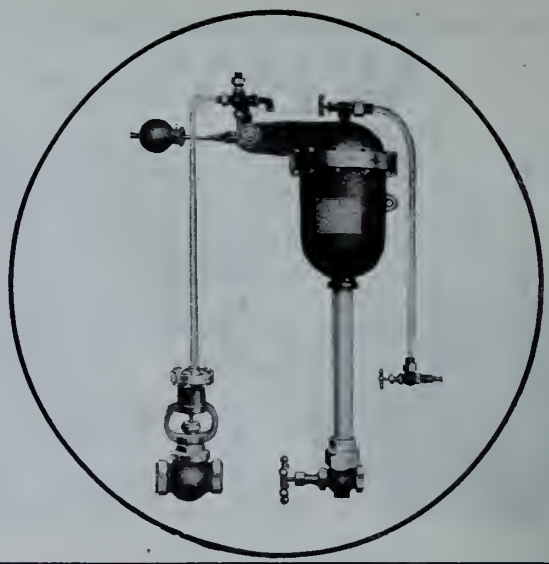
If any advertisement interests you, tear it out now and place with letters to be answered.

"McAVITY"
New Approved
Indicator Posts
for operating valves from 4 to 14 inch

For use with Valves for Fire Service in Corporations, Mill and Factory Yards, and in connection with Automatic Sprinkler Systems.
Approved by Fire Underwriters.

Write for copy No. 1004 *catalogue.*

T. McAVITY & SONS
LIMITED
St. John, N.B. - Canada
MONTREAL - WINNIPEG



It's Always There — Always Ready

THE Vigilant is always "on the job." With one installed your boiler room is free from the dangers due to high and low water.
It keeps the water level within ¼" of centre gauge. It is positive acting and absolutely dependable.
From records it has been found to effect a saving in coal of from 3 to 17 per cent.
Write for Vigilant catalog and our interesting and useful set of engineers' data cards.

The Chaplin-Fulton Manufacturing Company
28-34 Penn Ave., Pittsburgh, Pa.

Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

Regulating Valve Placed at Any Point, Any Position.

The "S-C" Regulator Company
Feed Water Regulation Engineers
FOSTORIA, OHIO, U.S.A.

A Well-Insured Plant

is the power plant of the Ft. Worth Light, Heat and Power Co., Texas. On the inside the coal is stored above the boilers in a Brownhoist Concrete Bin, which time has proved will last as long as the plant and require no repairs. The coal is unloaded on the outside by a Brownhoist Locomotive Crane, which takes it from the cars and places it in storage or puts it through the roof into the Brownhoist Bin. It is safe to say that this plant will have very little trouble, if any, with its coal handling apparatus.

BROWNHOIST

Concrete Coal Bin and Coal Handling Machinery

Write for Catalog S

The Brownhoist Concrete Bin is a steel bin, lined inside and out with concrete. This protects all steel from the corrosive action of the coal or ashes. The oldest one of these bins has been in continuous service for 14 years and has required no repairs. Brownhoist Coal Handling Machines are of various types and sizes for safe, rapid and economical handling of coal. These machines and the bin are described and shown in Catalog S.

The Brown Hoisting Machinery Co.

CLEVELAND, OHIO

Branch Offices in New York, Pittsburgh, Chicago, San Francisco, Montreal and (Portland, Ore., Colby, Eng. Co.)

You, Mr. Engineer

can greatly reduce your firm's fuse expense—in fact you can cut it down 80 per cent. by using

"ECONOMY"
Renewable Cartridge Fuses

They are no experiments—millions of them are in use.

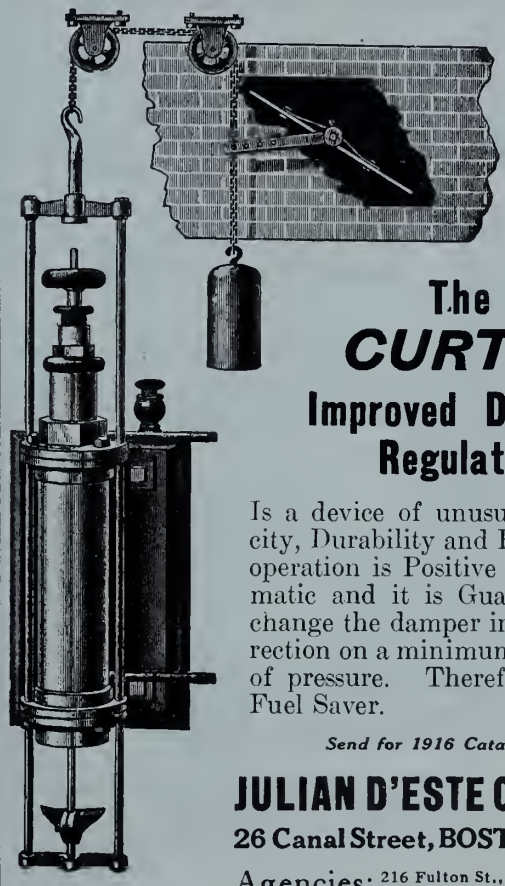
Made in Canada and sanctioned by the Canadian Fire Underwriters' Association

Free samples of any desired types and capacities sent with Catalogue No. 24. List of prominent users included

ECONOMY FUSE & MFG. CO. OF CANADA, LIMITED

UNITY BUILDING - MONTREAL

Manufacturers in Canada of "S. & C." High Potential Fuses,—to 150,000 Volts.



CURTIS
Engineering Specialties

The *CURTIS*
Improved Damper Regulator

Is a device of unusual Simplicity, Durability and Power. Its operation is Positive and Automatic and it is Guaranteed to change the damper in either direction on a minimum variation of pressure. Therefore it is a Fuel Saver.

Send for 1916 Catalogue.

JULIAN D'ESTE COMPANY

26 Canal Street, BOSTON, MASS.

Agencies: 216 Fulton St., New York City
174 North Market St., Chicago, Ill

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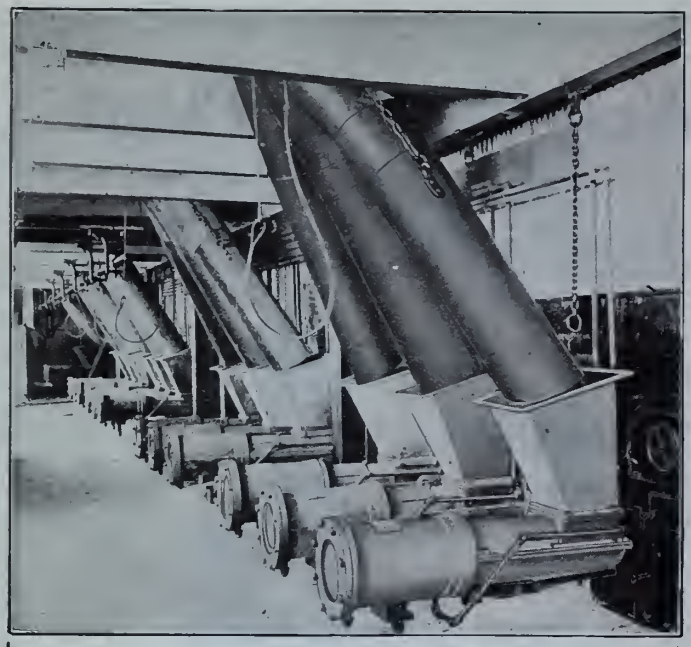


Well Equipped

The economic value of the Jones Underfeed Stoker, both in labor and coal, is rapidly being realized by a great many concerns. They readily see the scientific principle upon which the "Jones" is based. The fact that there is no smoke, no loss from sifting fine coal, no half-burned coal; all fuel must deliver **all** its heat before going to the refuse pile, has proven conclusively to a great number the enormous saving made possible by a Jones Stoker equipment.

Besides the saving in labor, the cleanliness and safety, this stoker will reduce your coal bill 15 to 25%.

If you have coal to burn you need a Jones Underfeed Mechanical Stoker. Let us get together.

Jones Underfeed Stoker Company, Ltd.

National Trust Building
TORONTO, CANADA

War on Boiler Scale

Like a submarine, the water does not bother Perolin a bit, nor does Perolin affect the water.

It's scale that I cruise around to find. Once I find him and make my presence known he surrenders with dispatch. You see scale knows I can outmanoeuvre him every time.

Here's why:

I drop through the water until I find the weak spots in scale's line of defence. There must be these weak spots or openings, because he hasn't the reinforcements that would enable him to cover every part of the territory. Into these openings I steer my course.

So I rush in at top speed, reach Fort Hot Boiler Metal—and it's all up with scale.

He quickly ceases all resistance, releases his hold, and drops a beaten man, a mere shadow of his former self.

Then I leave an amalgam on the metal which proves a fortification that he cannot penetrate—and the battle is over, mother.

Understand through the fight I respect the neutrality of Water, Gaskets, Lubrication, etc.—only scale knows that I am harmful.

If you've hoped for warfare of this kind in your boiler. I'm at your service—and so is the booklet that gives my full story.

Perolin Company of Canada
Limited

Office and Factory:

858 Dupont Street - TORONTO, ONT.

PEROLIN AGENTS: Engineers Supply Company, Winnipeg, Man. H. L. Peiler & Co., 380 St. James St., Montreal. Western Supply & Equipment Co., Limited, Calgary, Edmonton and Lethbridge. Bayfield & Archibald, 334 Seymour Street, Vancouver, B.C.

LUNKENHEIMER
"Renewo" Valves

" The Most Economical Valves for Steam Service"

REGRINDABLE SEATING SURFACES. RENEWABLE NICKEL SEAT AND DISC.

Installing "Renewo" Valves means permanence, and **maximum valve service with low cost of upkeep.**

Besides having regrindable seating surfaces and renewable **nickel** seat and disc, they are provided with the well-known Lunkenheimer **"Seat-guard,"** which materially aids in preserving the seating surfaces and keeping them clean.

The hub is held to body by the original Lunkenheimer union connection. The stuffing box has gland follower on sizes above ½-inch. The handwheel is of the self-cooling type on sizes up to 2 inches inclusive.

The materials and workmanship are Lunkenheimer "Quality."

The "Renewo" is the sum total of all the improvements discovered and developed in over half a century of valve manufacture.

Users ***know.*** A trial ***convinces.***

Inside Screw (as shown in illustration) and Outside Screw and Yoke types, for 200 and 300 pounds working steam pressures.

Descriptive booklet No. 535 from your local dealer or

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High-Grade Engineering Specialties in the World 1-12-43

New York **Chicago** **CINCINNATI, O., U.S.A.** **Boston** **London**

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., **Valve Specialists** **Walkerville, Ont.**

If any advertisement interests you, tear it out now and place with letters to be answered.

There are only two things that should go into a boiler—one is water, the other is—

"IMPERIAL" Boiler Coating

Imperial Boiler Coating is not a boiler compound. It contains in a highly concentrated form all the best chemicals and vegetable extracts known for removing scale; combined with a peculiar paint or coating, which forms on the boiler metal and resists all scale formation.

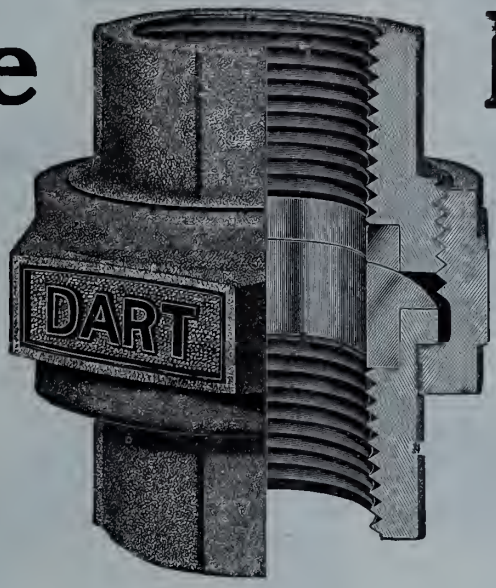
Imperial Boiler Coating has never failed to remove scale where it has been given a fair trial. To prove this we are willing to send you a sufficient quantity to satisfactorily treat your boiler against scale formation.

Satisfaction or no pay—Isn't it fair?
Write us to-day.

Crown Manufacturing Co.

CLEVELAND, OHIO

Bronze to Bronze



DART

DART

At the Joint—

And that is where the bronze is needed—at the joint, the vital part of the union, to prevent corrosion, and that is where Dart unions have it.

Then again, there is another feature, trifling it may seem, yet it adds wonderfully to its use and value. The ball-shaped seat. This ball-shape allows for an easy connection regardless of the alignment of the pipes. And of course it fits perfectly.

No leaks, no replacement, no upkeep costs. If any "Dart" union is defective in any way, we will replace it with two perfect ones.

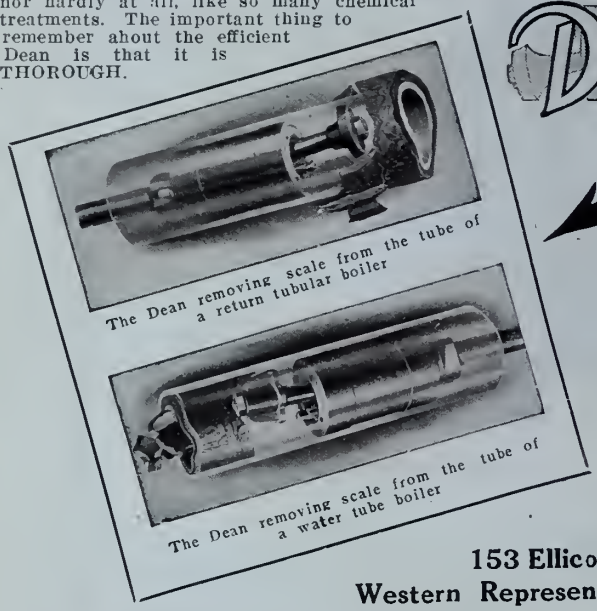
Does that spell CONFIDENCE?

Dart Union Co., Limited

Toronto Ontario Canada

Let One of These Machines Show You How It Cuts Coal Costs 5% to 35%

This machine will reduce your coal bill from 5% to as much as 35%, depending upon the amount of scale there is on your boiler tubes.
And don't say there isn't any scale on your tubes—because hundreds of engineers have received the surprise of their lives when this efficient scale remover was put through, only to bring out several hundred pounds of tube-burning, coal-wasting scale.
The Dean Boiler Tube Cleaner reduces coal bills, because it removes scale thoroughly—not partially, like so many other mechanical tools, nor hardly at all, like so many chemical treatments. The important thing to remember about the efficient Dean is that it is THOROUGH.



The Dean removing scale from the tube of a return tubular boiler

The Dean removing scale from the tube of a water tube boiler

Dean

The Dean Cleaner is operated by either compressed air or steam. Its rapid stream of vibrations on the tube wall—from 4,000 to 8,000 per minute—bodily shakes the scale loose, causes it to disintegrate, break up into small pieces and fall.
No scale, no matter how hard, thick it may be, can resist the tremendous power of vibration. The very operating principle of the Dean Cleaner is a practical insurance of complete scale removal.
If you think your present method is effective and the best possible way of removing scale, send for a Dean and try it out in competitive test. Make the Dean do every stunt you can devise—and you'll find that it will do your work quicker and much more thoroughly than you ever thought possible.

How to Order a Dean for Free Trial

We will gladly loan you a Dean Cleaner for absolutely Free Trial, without the slightest obligation on your part to purchase. To secure a Dean, simply tell us the exact outside diameter of your boiler tubes and whether your boilers are water-tube or return-tubular. If you don't want it after trial—just box it up and ship it back.

For detailed description of the Dean, ask for booklet "The Logic of the Dean."

The WILLIAM B. PIERCE Co.

153 Ellicott St., Buffalo, N.Y. - 201-2 Coristine Bldg., Montreal
Western Representative: W. W. HICKS, 567 Banning St., Winnipeg

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways.
W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

OILS
GREASES
Etc.

TRADE MARK REGISTERED IN
NON-FLUID OIL
UNITED STATES PATENT OFFICE

Outlasts measure for measure other lubricants of any description, regardless of price.

Lubricates with least friction but does not drip, spatter and waste like fluid oils.

Lasts three to four times longer than fluid oil.

Does not require the aid of frictional heat before it begins to feed, a fault usually found in greases.

Remains the same consistency summer and winter.

Begins to feed the instant the journal starts to revolve. Feeds only when the journal turns—only as fast as needed. When you feed Non-Fluid Oil to a bearing, you have positive assurance that there will be no overheating as long as a particle of this superior lubricant remains.

We strongly advise a long accurate test of the claims we have made for these lubricants. Samples for the purpose will be gladly furnished free on request. Ask for literature giving full particulars.

FRED. SMITH

Church Street Toronto, Ont.

If any advertisement interests you, tear it out now and place with letters to be answered.

(PATENTED)

"AMERICAN"
All Steel Split Pulleys

Better than cast iron because of much less belt slip.

Better than wood—they hold a belt as well and wear better, and are not a fire risk.

"American" Steel Pulleys, made by the American Pulley Company, are better than other steel pulleys, because they are stronger, better made and use less power because of less windage.

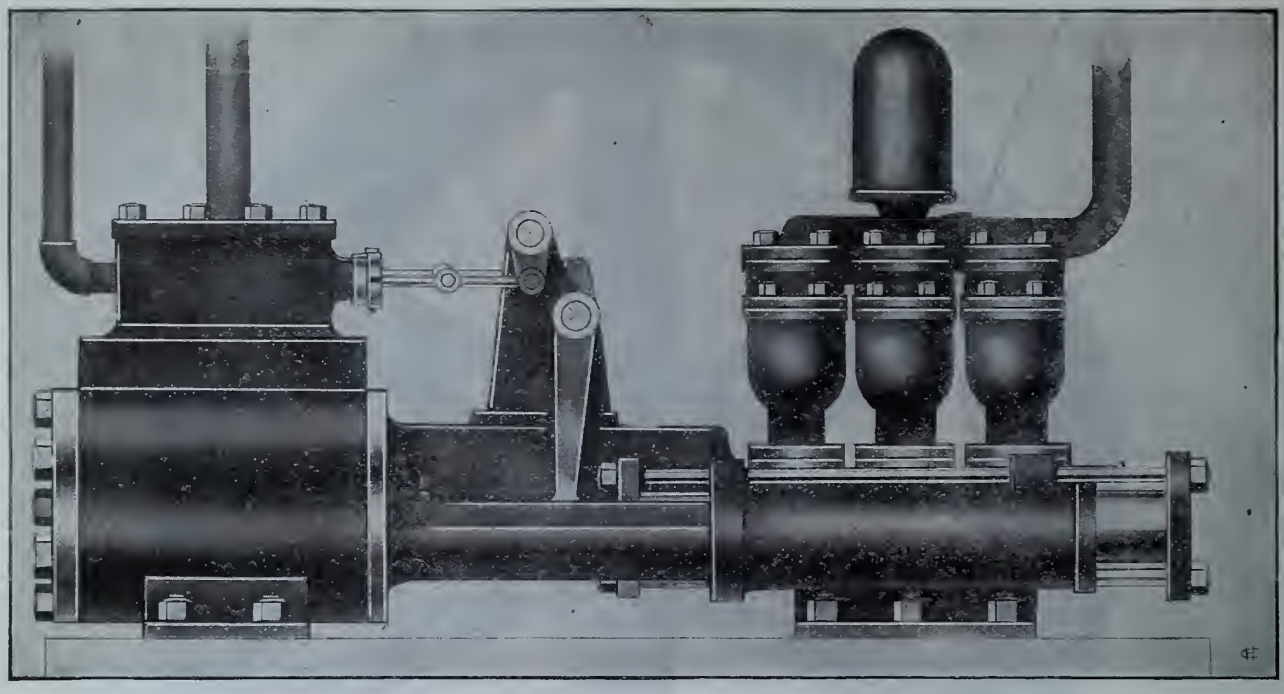
Stock sizes—3″ to 72″ in diameter
Larger diameters to specifications
Special pulleys for unusual duty
First All-Steel Belt Pulley made

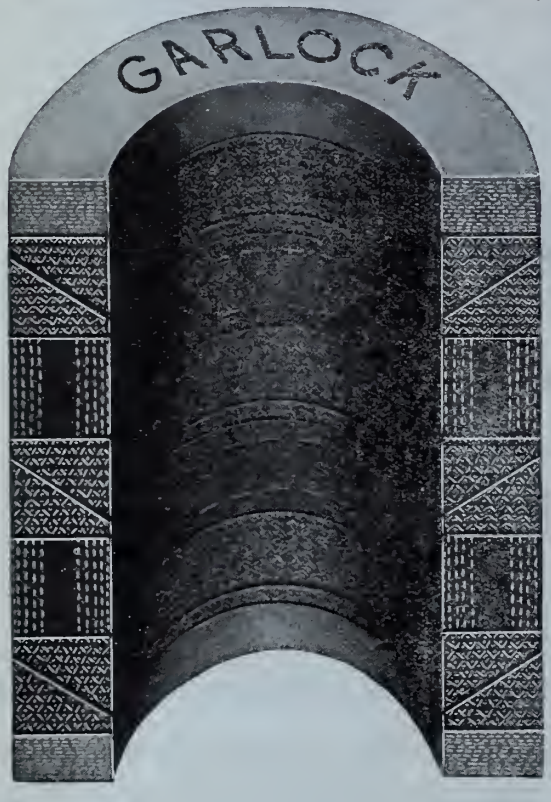
First in Volume of Sales
First in Efficiency
First in Esteem of Users
Interchangeable bushings

The American Pulley Company, 4234-60 Wissahickon Ave., Philadelphia, Pa., U.S.A.

Williams & Wilson, Limited, Montreal

The A. R. Williams Machinery Company, Limited, St. John, N.B., Toronto, Winnipeg. Vancouver





Garlock 1907 Combination Packing

Especially adapted for outside packed plungers of pumps handling extremely hot water. It is composed of Garlock Special Hydraulic, Diagonal and Cushion Center Rings, which make it a strong and elastic packing, easy wearing on rods. There has been a long felt want for packing that would give satisfactory service on hot water rods and outside packed plungers, and this combination is the best known packing for that service. A trial will convince you.

Write for catalog describing our many styles and combinations of packing.

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This Quality Guarantee appears on every piece.

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Every inch of our belting is reliable, while our prices are the lowest—quality considered."

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is used by many of Canada's largest and best equipped power and industrial plants.

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VINCENNES BOARD & PAPER COMPANY.

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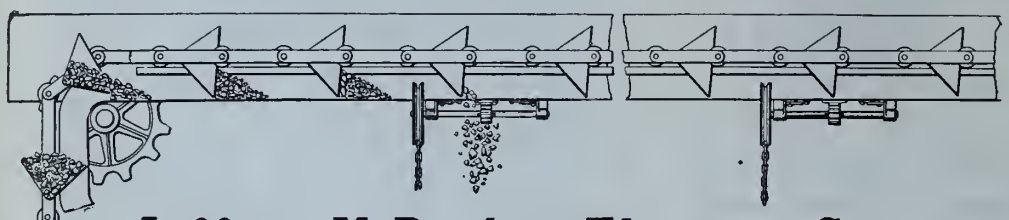

Jeffrey V-Bucket Elevator-Conveyer

For Small-Sized Power Plants— For Outdoor Storage of Coal

The V-Bucket Conveyer is especially adapted for handling Slack and Stoker Sized Coal. It is low in first cost; Simple, Durable and Economical in operation. May be used either as a Run-A-Round Conveyer or as a Combined Elevator and Scraper.

Built in various sizes of both Buckets and Chains to meet capacity requirements.

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V-Buckets in vertical position mounted on "Flat and Round" Steel Link Chains, with and without guides for chains.

V-Bucket in a horizontal position with steel plate trough for buckets and steel bar strips under chains.

Upper Run of Jeffrey V-Bucket Conveyer mounted on large Roller Malleable Chain.

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"Lincona"

BALATA BELTING

will pick up a load suddenly better than any other type of belting

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it has a GRIP that no other belting has and requires no dressing.

"Lincona" will give you the maximum transmission of power

"Lincona" is the strongest Balata Belt Made.

The tensile strength of "Lincona" is almost double that of leather belting and there is less stretch and straighter running than any other type of belting.

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"Lincona" Balata Belting can be exposed to snow, rain and every condition of weather without injury. It can be run in water without trouble. Write us about your specific needs.

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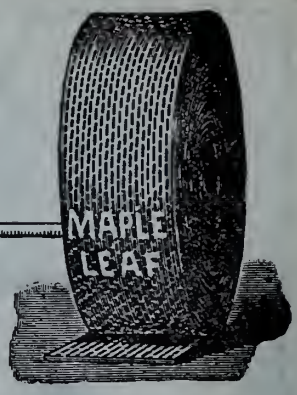

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Excels all others in economy, strength, efficiency and true running, whether for Transmission of Power or Conveying.
A test recently made at McGill University, Montreal, of 6-ply "Maple Leaf" Belting, light double leather, and 6-ply rubber, showed that our "Maple Leaf" stood a breaking strain 50% greater than the leather, and 25% greater than the rubber belt.

A trial belt will convince you.
Write for prices and samples.

Maple Leaf Belt Dressing
The BEST for all kinds of belts

Dominion Belting Co., Limited
Hamilton, Canada

Goes Right on Your Present Valve Wheel

"Goes on" is about right, too, it's so easy to apply, and by putting a

Babbitt Adjustable Sprocket Rim

on each of those hard-to-get at overhead valves you can save a lot of time you now spend in hunting ladders and all the risk you now run in using them after you've found them. One concern that thought two would do, bought 27 in a little over two months. The price will encourage you to have enough of them.

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ROTO TUBE CLEANERS

Type A. D.—Driven by Air or Steam
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More power from your boilers.
Less coal per power produced.
No burned out boiler tubes.

The only cleaners for hardest scale.
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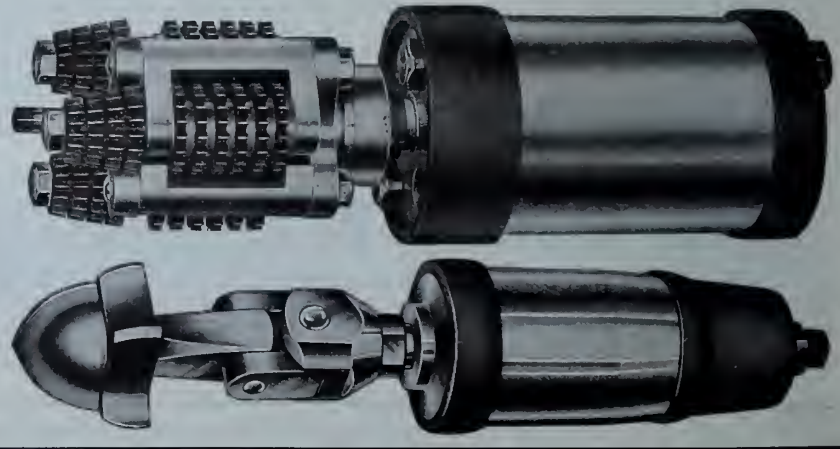
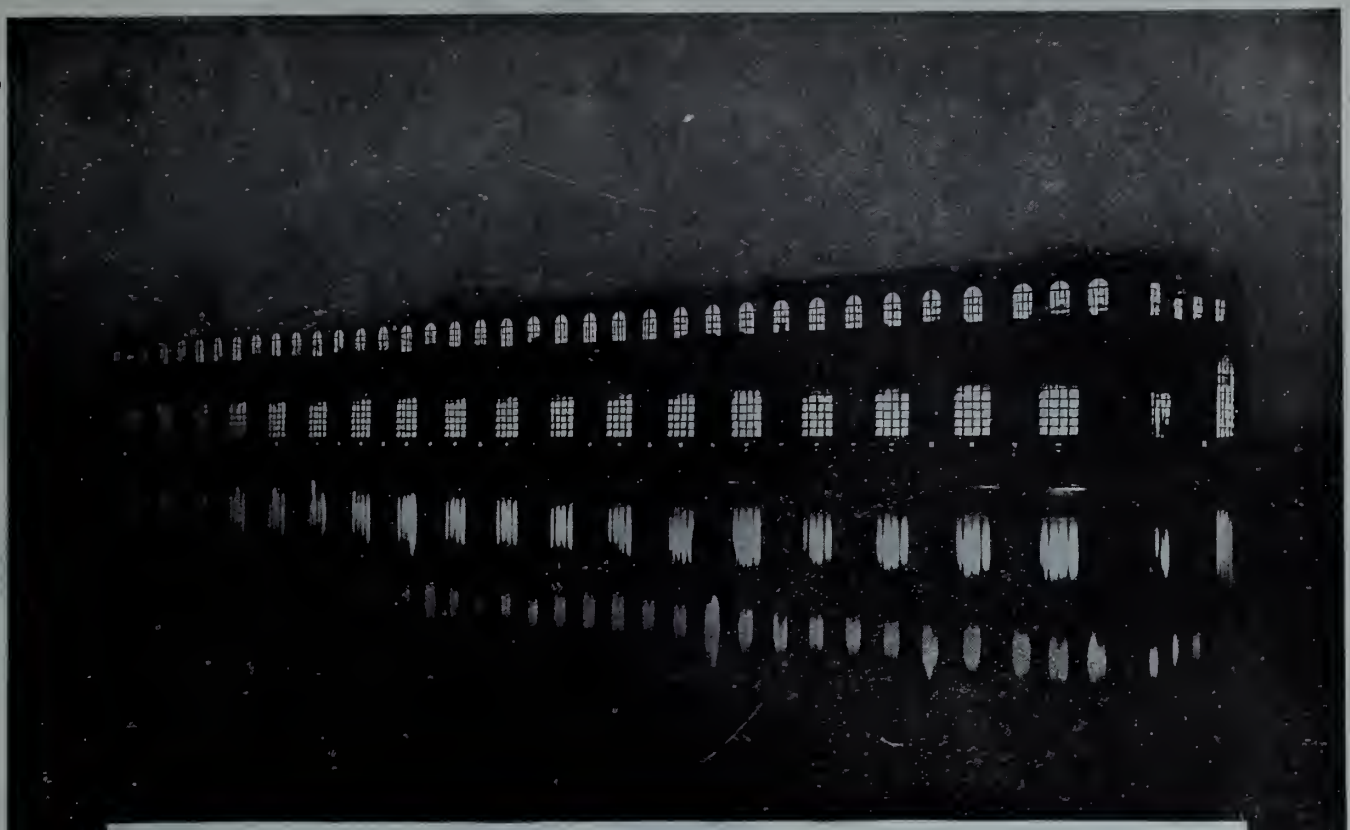
Standard of the largest power plants.

THE ROTO COMPANY
Write for Catalog HARTFORD, CONN.





The Power House at Keokuk, on the Mississippi River, by night.

The World's most important power plants employ Silent Chains (MORSE, of Course)

Eleven 23 H.P. Oil Pump Drives (as illustrated below) are located in the Keokuk Power House. Seventy-two 24 H.P. drives are employed at Panama for operating the safety gate hoists. The largest chain drive in the world (5000 H.P.) drives a generator in a western power plant.

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Please send copies of your Latest Publications to the address given below. Also name preliminary proposition for a MORSE Silent Chain Drive as per the following specifications:

Maximum H.P. to be transmitted .....
Drive from ..... to .....
R.P.M. of driver .....Of driven .....
Distance between shaft centers .....inches
Daily use desired of about .....hours
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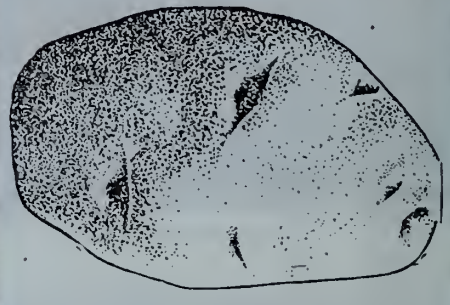
OILS

These Lubricants give remarkable service. They will keep your machinery running smoothly, easily and with a minimum of wear and cost.

No better time than now to put them to the test. The prices are very reasonable.

Potato Scale Powder Boiler Cleanser



Will positively rid your boilers of old scale and will *keep* tubes clean if but a small amount is fed daily through the feed water.

Eliminates foaming, pitting or any other boiler troubles due to impurities in the water supply. *Makes big reduction in fuel bills.*

Sold UNDER A POSITIVE GUARANTEE. Try a Barrel.

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CLING-SURFACE does the trick every time

Read these three letters, order a trial tin, give a fair test and YOU will be just as enthusiastic.

"How am I coming on with Cling-Surface? I am not coming on—I AM on. No slip. No squeak. Running like a top. What more should I want?"

And in the same mail, another: *"Good belt service from Cling-Surface is the best paying investment in our place."*

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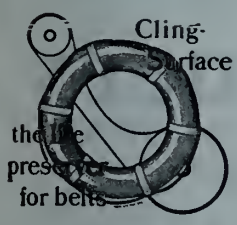
A trial of Cling-Surface at a few cents cost will bring you *immediate, marked* and *lasting* belt improvements. Send at least for literature.

We quote f.o.b. Toronto.



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1057 Niagara Street
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I am interested in Cling-Surface and your trial order proposition.

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PROTECT YOUR BEARINGS

from overheating, from seizing and from pitting by the use of a fine tallow compound possessing a low melting point and a high lubricating factor. Such a lubricant is

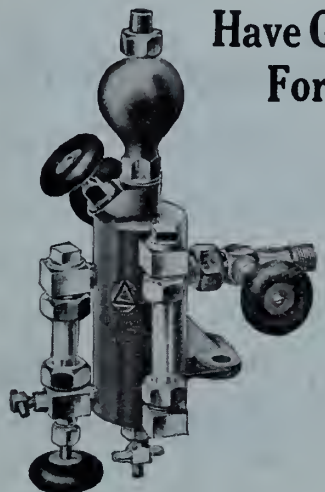
ALBANY GREASE

which contains nothing harmful to bearing surfaces. Albany Grease can be used in any kind of grease cup. Send for a quantity of Albany Grease and an Albany Cup for trial. Write now

ALBANY LUBRICATING CO.
ADAM COOK'S SONS, Props.
708-10 Washington Street - New York
Established 1868

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

If any advertisement interests you, tear it out now and place with letters to be answered.

Do It Now

This month is the most opportune time to consider how the heat of the coming summer will affect your business. Prepare now. Let us advise and help you plan the most suitable Cooling Equipment for your particular use.

The Linde Canadian Refrigeration Co., Limited

37 St. Peter St., Montreal

Established and Manufacturing in Canada since 1896

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones. AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Corliss Engines *Special Machinery*

THE VILTER MANUFACTURING COMPANY

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Mention this paper when writing advertisers. It will identify the proposition about which you require information.

Mechanical Refrigeration

Saves Money—Increases Profits

By reducing your operating expenses and increasing your output, MECHANICAL REFRIGERATION paves the way to greater profits.

By improving the quality of your product, and keeping it up to standard it enables you to broaden your field and add new patrons.

But these results are possible only when the Refrigerating Equipment is correctly designed and properly installed.

We are constantly increasing our sales by reason of the excellent performance of existing YORK Plants.

We can serve you equally well. Write us for information and prices.

YORK MANUFACTURING COMPANY

(Ice Making and Refrigerating Machinery exclusively)

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REPRESENTED IN THE DOMINION BY

CANADIAN ICE MACHINE COMPANY

MONTREAL, 626 Coristine Building. TORONTO, 82 Chestnut Street. WINNIPEG, 85 Lombard Street.

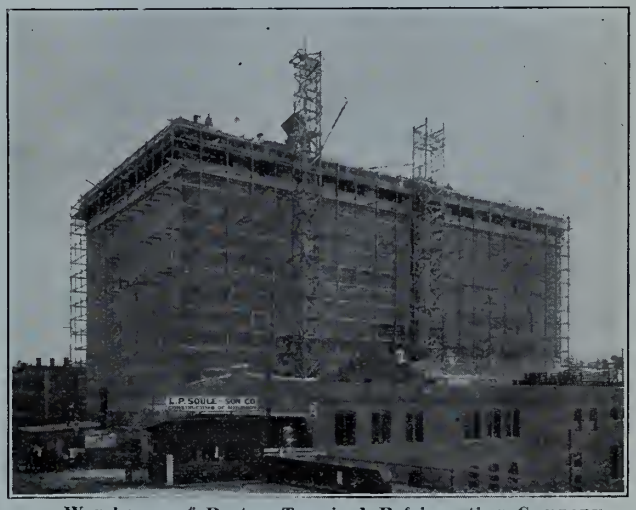
Under Water Twice-a-Day for Six Years

The Boston Terminal Refrigerating Company, East Boston, Mass., have three 6-inch suction lines laid in an ordinary non-waterproof concrete trench. The bottom of this trench is two feet below high tide level. Consequently, the

NONPAREIL CORK COVERING FOR COLD PIPES

with which the lines are covered, is under water twice-a-day. This is exceptionally severe service, such as is seldom encountered. Even so, the Nonpareil Covering is giving perfect satisfaction; and, in the words of the Judd Engineering Company, Boston, Mass., who made the installation,

"We were obliged to bale the water out of this trench, dry it, and insulate the pipe between tides. The plant has now been in operation for a period of six years, and we have never had the slightest trouble with these pipes."



Warehouse of Boston Terminal Refrigerating Company, East Boston, Mass.

Incidentally, the warehouse, which is shown above, is insulated throughout with Nonpareil Corkboard. It contains 1,500,000 cubic feet of cold storage space, yet last summer only 6,000 pounds of coal per 24 hours were required to run the entire refrigerating plant, three hydraulic elevators, and the generator for light and power.

The remarkable service that Nonpareil Cork Covering and Nonpareil Corkboard give is due to the high insulating quality of the cork and its remarkable ability to resist moisture.

Armstrong Cork & Insulation Co., Limited 504 McGill Bldg. Montreal, Que.

Also Manufacturers of Nonpareil Corkboard for cold storage rooms and Nonpareil High Pressure Covering for steam lines.

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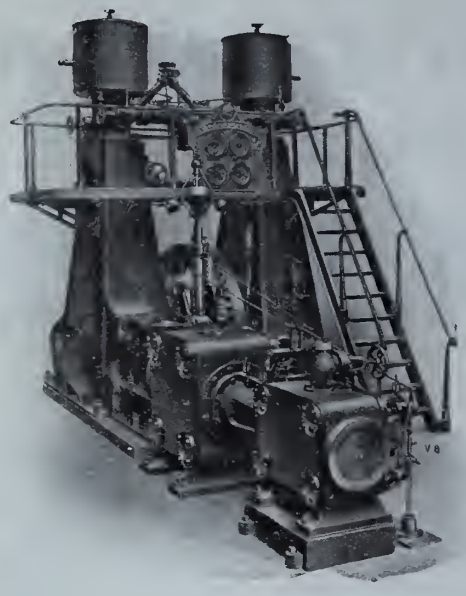


Why not operate your Plant with the highest efficiency and economy?

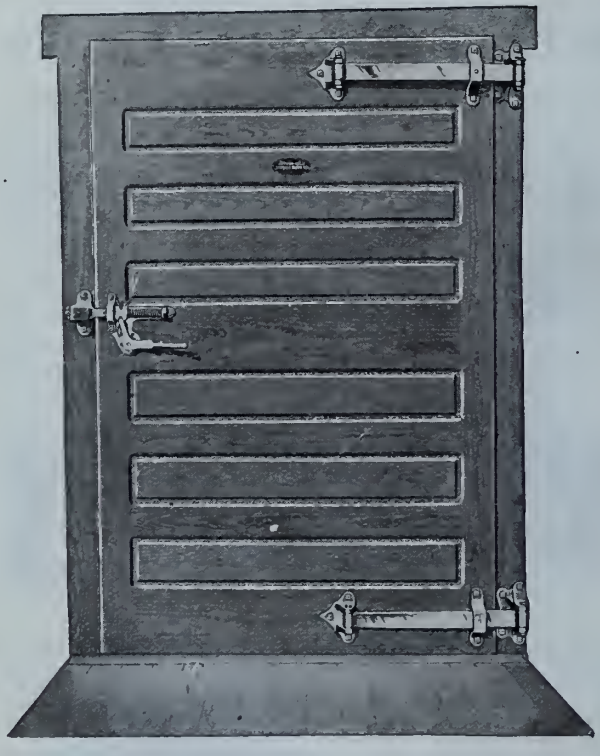
Write us advising what you have been doing and what additions you have contemplated.

Our Engineering corps will advise you impartially the best type of Plant for you to install and what you will need to reach the highest efficiency and lowest costs.

Get our new Fitting Catalog.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives:
THE FRICK ICE AND REFRIGERATION COMPANY, 357 St. Catherine Street West, Montreal



DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because:

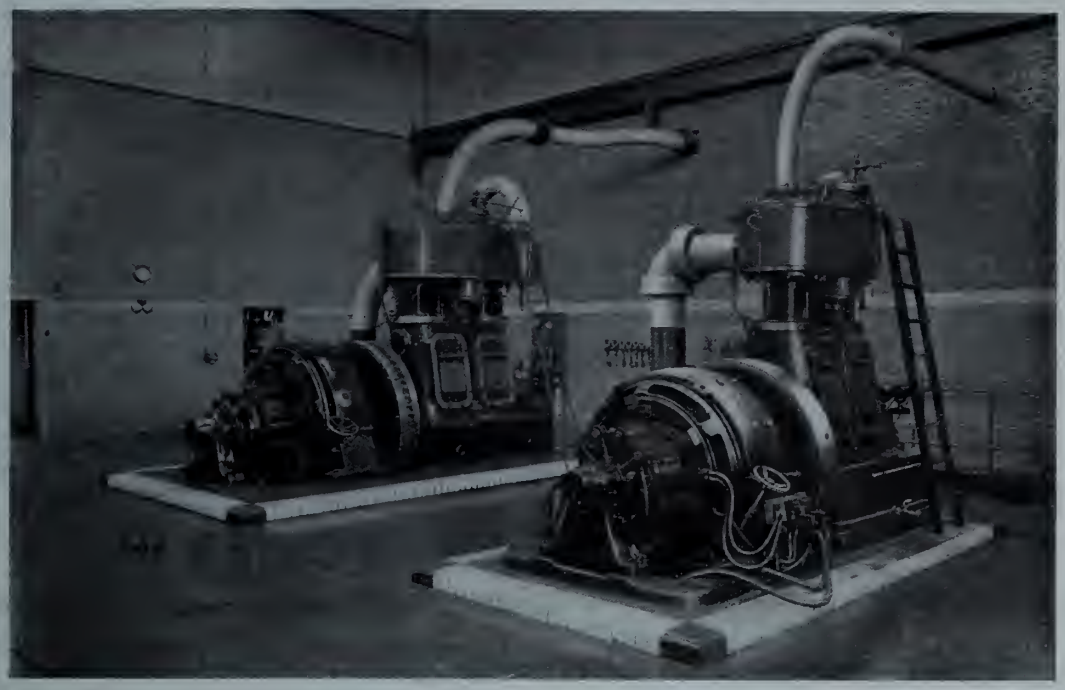
1st—Only the best materials are used in their construction.
2nd—We use heavier materials. Result: Longer life and increased efficiency.
3rd—Our doors are built with double and triple seals of contact—others have but one.
4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.
5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
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Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

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Engineers

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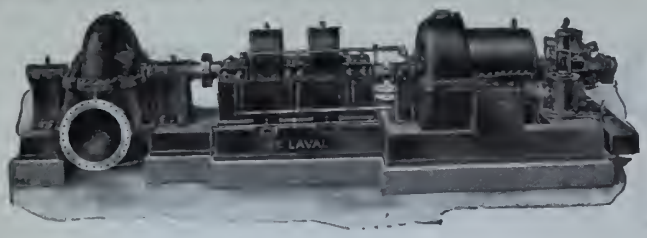


High Duties From De Laval

Steam Turbine Driven Centrifugal Pumps

De Laval Steam Turbine-driven Centrifngal Pnmps have long held the records for efficiency. The latest is 168.3 million foot lb. per 1,000-lb. steam at 140-lb. gage and 100° F. superheat, established by a De Laval Turbine-driven Pump at the Low Level Pumping Station of the Montreal Water Works. This pump supplies 30,000,000 Imperial gallons per day against 210-ft. head.

The high dnty turbine-driven centrifngal pnmp was made possible by the De Laval Donble-helical Speed-redncing Gear. Speed-redncing Gears can be nsed to advantage with centrifngal pumps wherever high tnrbine and high pnmp efficiency are desired, or where relatively large volumes of water are to be pnmped against low heads as **in circulating condenser water.**

Where small quantities of water are to be pumped against high heads and where the exhanst of the tnrbine can be nsed in feed water heaters or manufactnring processes, directly connected nnits are more simple and less expensive. **Turbine-driven centrifugal boiler feeders,** for example, are bnilt in sizes from 2,000 to 50,000 boiler horsepower. There are no parts in actnal contact, except the bearings and the simple packings about the shaft and no valves, plungers or pistons. All working parts are accessible upon lifting the casing covers and withont disconnecting piping. The feed line is free from shock, which is favorable to the use of boiler feed regnlators. The exhaust steam is uncontaminated with oil.

De Laval designs are distingnished by moderate peripheral speeds, large running clearances, horizontally split casings and accessibility, close regnlation, limit gage method of mannfacture, and interchangeability of parts, and every unit is guaranteed and tested before shipment.

The many different applications of centrifugal pumps, together with their Design, Manufactnre, Testing, Characteristics and Selection are fully explained in our 300-page Book B61.

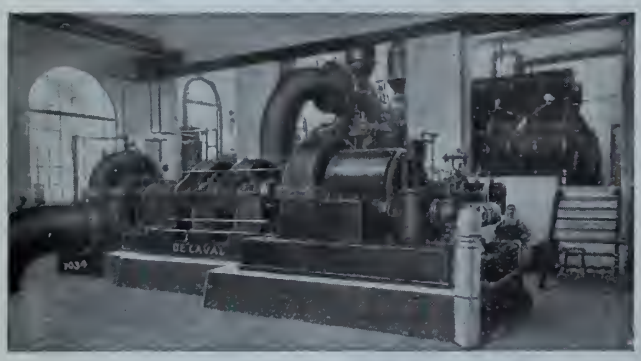
DE LAVAL

STEAM TURBINE COMPANY

Trenton . - - - N. J.

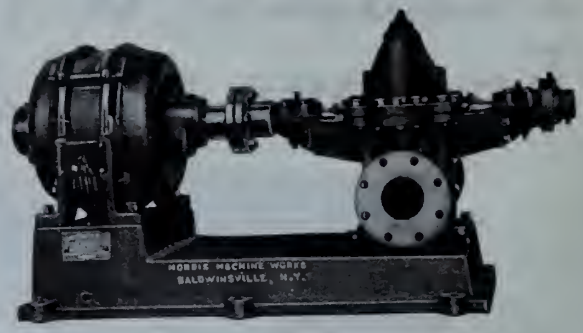
224

De Laval Steam-tnrbine-driven Centrifugal Pump installed at the Low Level Pumping Station of the Montreal Water Works; 30,000,000 Imperial gal. per day against 210-ft. head; duty 168 million ft. lb. per 1,000 lb. of steam at 140-lb. gage pressure; 100 deg. snperheat.



A De Laval combination pumping unit supplied to the Montreal Water Works. Geared steam turbine drives a single-stage pump supplying 900 gal. per minute against 100-ft. head as circnlating water for the condenser of a **De Laval** turbine-driven gas blower, and a multi-stage general service pnmp, snpplying 600 gal. per minute against 285-ft. head.

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2" to 20" discharge.

Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.

Builders of Centrifugal Pumps, Hydraulic Dredges, Steam Engines

Canadian Sales Agents:

Storey Pump & Equipment Co., Toronto, Can.

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of **paying for themselves** in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

CANADIAN *Sirocco* COMPANY LIMITED

WINDSOR. ONTARIO.

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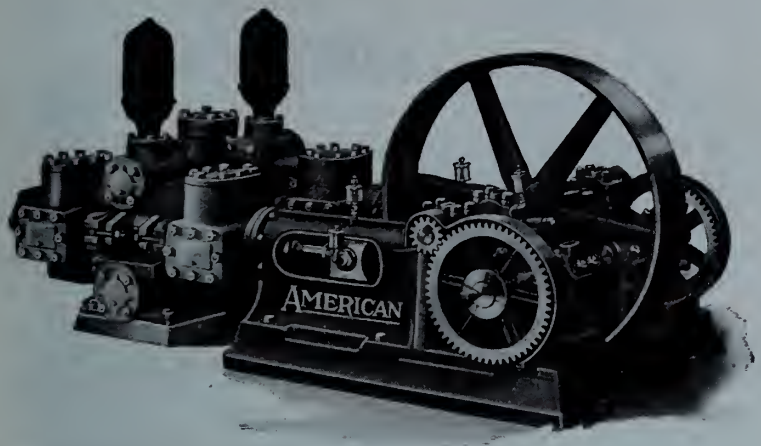
MARSH and AMERICAN

Pumping Machinery. Steam and Power Driven

The world has used and endorsed over 130,000 Marsh and American Pumps. Twenty-seven years of pump manufacture have proved our ability and perfected our facilities. Marsh and American Pumps are 100 per cent. correct—from the selection of raw material and accuracy of design to the actual pumping service, day in and day out, year after year. They ask no apologies and never have to explain away any error in service or failure in efficiency.

Investigate. Ask for our 250-page catalog illustrating and describing the line. Your pumping problems will be answered fully and satisfactorily through this investigation. This catalog will be sent by return mail in answer to your inquiry. Your copy is awaiting your prompt request.



American Duplex Belt-Driven Boiler Feed Pump. Outside Packed Plunger Pattern.

AMERICAN STEAM PUMP COMPANY

BATTLE CREEK, MICH.

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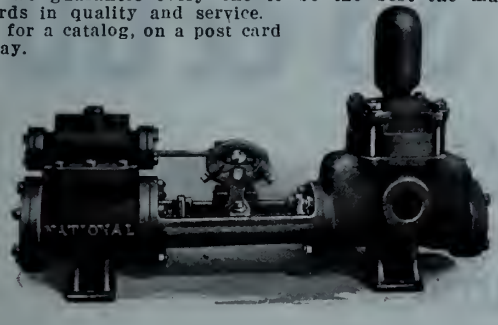

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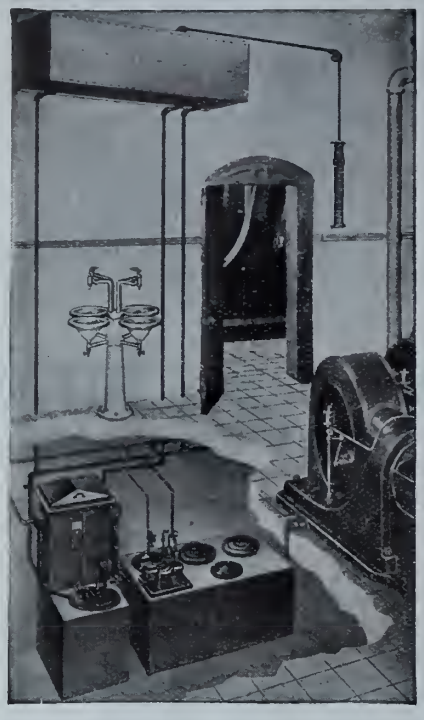

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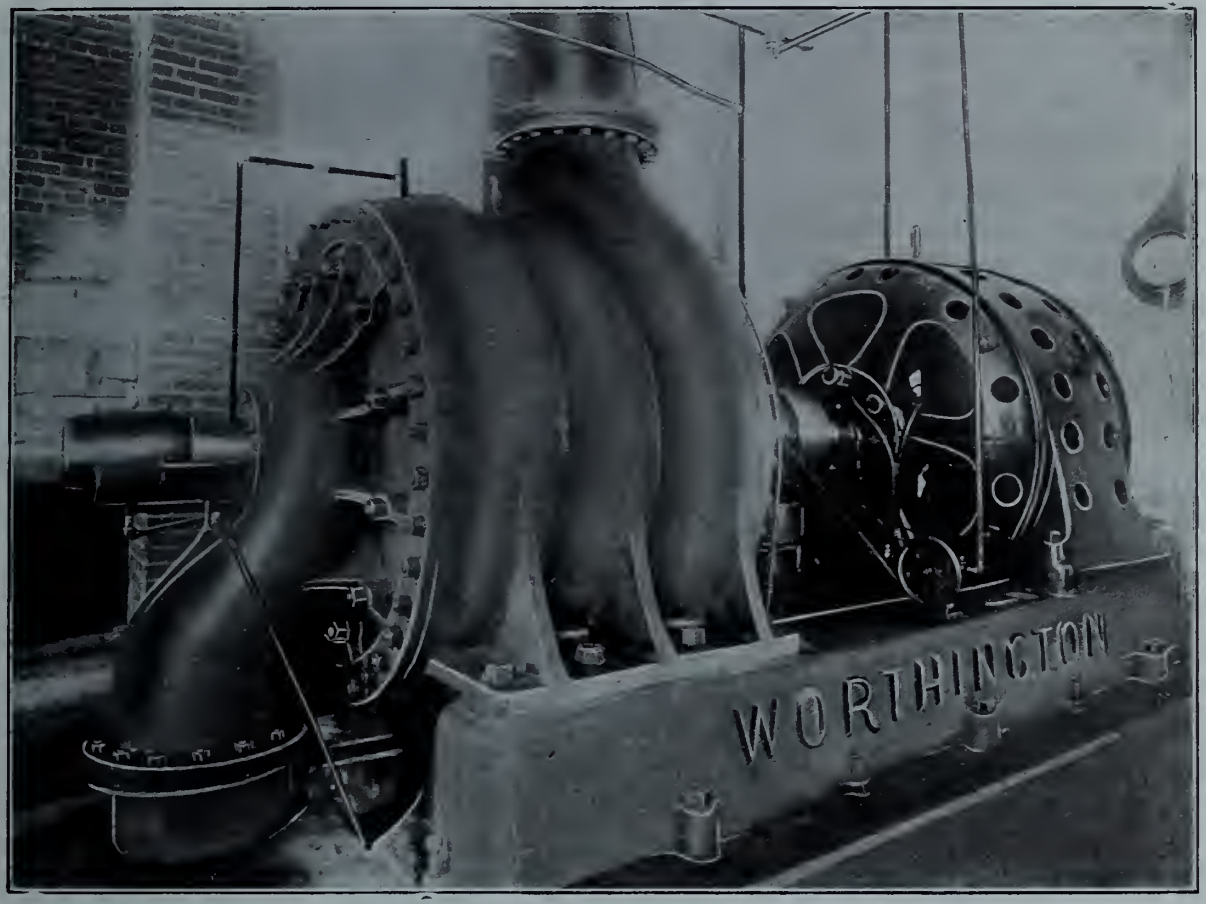

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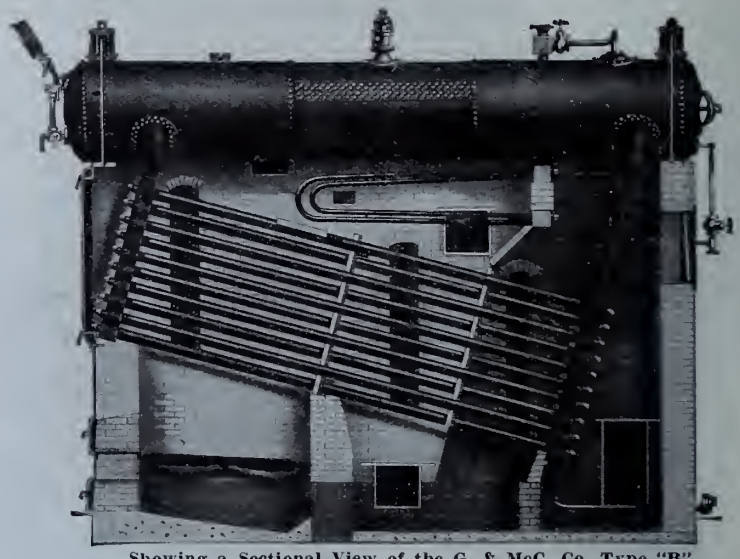

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Plant and Equipment of Vancouver Ice and Cold Storage Co.

By A. F. Adams *

Ice manufacture and cold storage have in recent years become what might be termed staple industries, and, in the case of the Pacific Coast, the growth of such plants has been parallel with the development of the principal products of the country. Fruit and fish are two items alone, the commercial success of which has been greatly facilitated by the availability of such substantially equipped plants as are described and illustrated in the following article.

THE plant of the Vancouver Ice & Cold Storage Co., Ltd., at Vancouver, B.C., is located in close proximity to the water front and consists of three buildings arranged as shown in Fig. 1, the main engine room being located in No. 1 building, while Nos. 2 and 3 buildings contain ice tanks and ice storage rooms. A 40-ton compressor, however, is located in No. 3 building, to be used in case of emergency, or in the event of fire or accident putting the main plant out of commission. The wisdom of this arrangement was demonstrated in May, 1916, when a destructive fire occurred on the wharf, completely destroying a large hay and grain establishment along with a grain elevator. The damage sustained by Nos. 1 and 2 buildings was confined to the roof as a result of the efforts of the fire department, assisted by a favorable wind. These buildings are of wooden construction throughout, while No. 3 building is of tile and concrete, and as far as possible, is fireproof. An exterior view of No. 3 building is shown in Fig. 2, with the railroad tracks at the head of the buildings; an interior view is also given in Fig. 9.

Compressor Installation

Four ammonia compressors, ranging from forty to one hundred and thirty-five tons capacity, are installed in No. 1 building. They are all of the horizontal double acting type, and include both steam and motor-driven units, their capacities, etc., being as follows:—

One 40-ton Triumph compressor, built by the Triumph Ice Machine Co., Cincinnati, chain-driven by a 75-horse-power, three phase, 2,200 volt Westinghouse three bearing motor.

One 65-ton Linde compressor built by the F. W. Wolf Co., Chicago, driven by a 16 in. x 42 in. simple Corliss engine made by the Minneapolis Steel & Machinery Co.

Two Niebling compressors, one 75 and one 135 tons capacity, built by the F. W. Niebling Co., Cincinnati. The smaller machine is driven by a 12 in. x 24 in. x 30 in. tandem compound Corliss engine, made by the Laurie Engine Works, Montreal. This unit is shown in illustration, Fig. 3, while the larger machine is shown in Fig. 4. This latter machine is rope driven by a 400 horse-power, three phase motor, see Fig. 5, the reason for such a large motor being to provide for the installation of another compressor as soon as the demands of the business justify it.

The growth of the business is illustrated by the fact that a 30 kw. set formerly used for lighting and elevator service, is not now sufficient for all of the buildings and is only used as a standby for lighting purposes. This unit is shown in Fig. 6, the generator supplying 220 volt a.c. current. It is direct connected to a Robb engine, with exciter on same shaft. The switchboard, one end of which is visible in Fig. 6, is fully equipped with transformers, volt meters and ammeters. The Robb engine has a stroke of 9 in. with a cylinder diameter of 8 in., and operates at 400 revs. per min.

Boiler and Condenser Plant

Steam requirements of the entire plant are supplied by two Babcock & Wilcox water tube boilers of 300 horse-power capacity. See Fig. 7. This includes steam for the engines and pumps, and also the steam requirements of a large ice cream plant, which occupies a portion of No. 1 building. The boilers are fired by mechanical stokers of the Babcock & Wilcox chain grate type, being driven by a small steam engine, which also drives the fan for the induced draft system. The control of this engine is of an interesting nature, the speed being governed by a regulating valve in the steam line, which passes more steam to the engine if the pressure falls, giving increased speed and feed to the stoker, while the reverse operation takes place if the steam pressure rises. Very little variation of the steam pressure takes place with this system of firing control. A motor operated bucket conveyor takes the ashes to an overhead hopper.

The steam pressure carried is 160 lbs. per sq. in., which is reduced to 115 lbs. for the simple Corliss engine and pumps, by means of a Davis pressure regulator. Boiler feed requirements are taken care of by a standard Weir feed pump, a Penberthy injector being installed for emergency use. A Webster vacuum feed water heater and purifier is installed which raises the temperature of the feed water to about 210 deg. F.

The exhaust steam from the compressor engines passes into a surface condenser, the vacuum pump being of the Fairbanks-Morse direct-acting type, a vacuum of 26 in. of mercury being maintained regularly. A Cranetilt vacuum trap is installed on the exhaust line between the engines and condenser for the purpose of removing oil and condensation from the line which it does without destroying the vacuum.

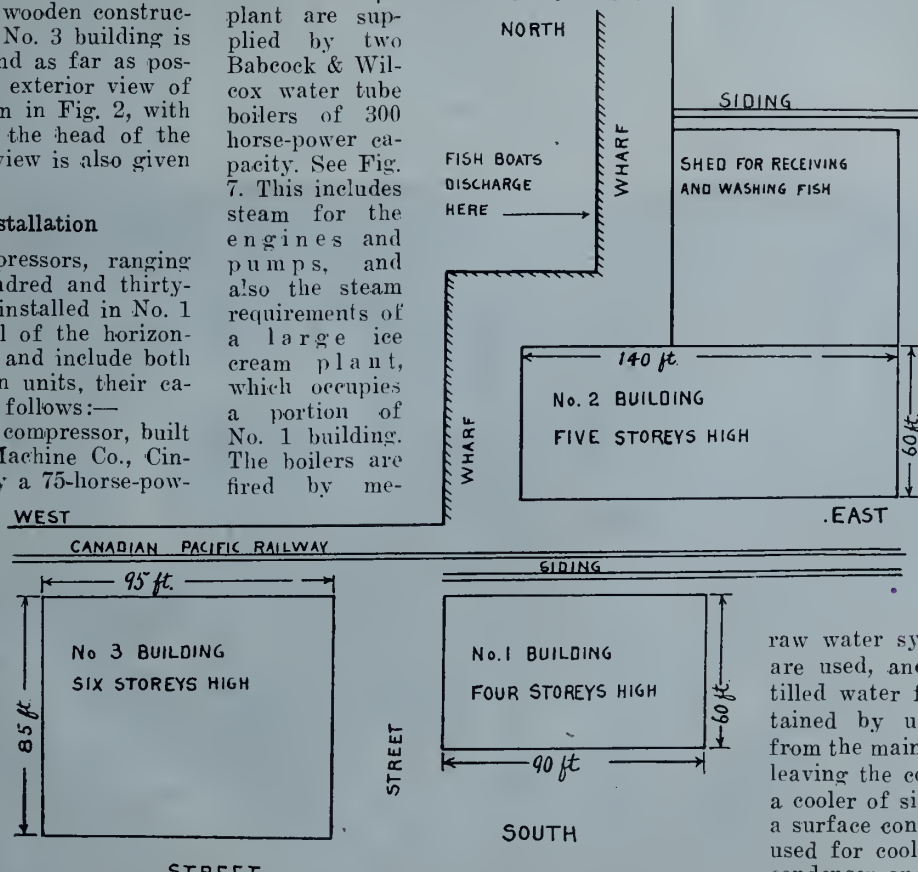


FIG. 1. PLAN OF VANCOUVER ICE AND COLD STORAGE CO. PLANT, SHOWING LOCATION OF BUILDINGS AND WHARF.

Cooling Water Systems

Both distilled and raw water systems of ice making are used, and the supply of distilled water for the former is obtained by using the condensate from the main engines, which, after leaving the condenser, is cooled in a cooler of similar arrangement to a surface condenser. Sea water is used for cooling purposes in both condenser and cooler, being circulated by a Weir land type of feed pump, the use of salt water necessitating a bronze water end on the pump. Temperatures of this cooling water during 1916 were 54 deg. F., in July, and 46 deg. F., in November. The sea water is obtained through an 8-in. cast iron pipe laid in a tunnel, which passes underneath the railway tracks, the maxi-

*Plant Chief Engineer.

mum lift of the circulating pump being fourteen feet at low tide, decreasing to a minimum at high tide. A duplicate pump installation is installed in connection with this system.

The ammonia condensers in use are of both atmospheric and counter-current double pipe types, and are cooled with fresh water which is maintained at a suitable temperature by a cooling tower carried well up above the roof of the building to secure a good circulation, Weir pumps being used in connection with the cooling tower.

Ice Tanks

The ice tanks and ice storage rooms are located in Nos. 2 and 3 buildings. As mentioned above, both distilled and raw water systems are in use, but the conversion of the plant to the manufacture of raw water ice entirely is at present under consideration.

The McCormick raw water system is employed, in which the drop pipes are connected to a header, which is removed from the tank when the ice is formed, other systems requiring the removal of one or two pipes, per can as the case may be. A very satisfactory blower is used for supplying air to this ice system, being the product of a local firm and having been in constant operation for the past eighteen months. This machine is particularly quiet in operation and gives as good service to-day as when first installed.

The distilled water ice tank is fitted with special handling apparatus which enables the crane to lift twelve cans at once instead of one or two, as ordinarily done. After being lifted from the tank, the cans are dipped in warm water which loosens the ice, after which the cans are lowered into such a position that the loosened blocks of ice slide out on to an elevator platform. The elevator lowers the ice to the storage room, which is immediately below the freezing tank, thus making it unnecessary to lift the ice at any stage of manufacture. Standard 300-lb. cans are used, and storage is provided for 1,500 tons of ice.

FIG. 2. EXTERIOR VIEW OF NO. 3 BUILDING.

Fish Freezing and Storage

In addition to ice making, No. 2 building is used for freezing and storing fish for local firms. The interior of one of the freezing chambers is shown in Fig. 8, the temperature when the photograph was taken being 12 deg. F. below zero. The method of refrigeration followed in this plant is to have a temperature of at least 5 deg. F. below zero, using lower temperature if the fish are large, and freezing as much as 100,000 pounds in one batch. When thoroughly frozen, the fish are taken to the dipping and packing room adjoining the freezers, and in which the fish are maintained at a constant low temperature until they are glazed and packed, after which they are placed in the storage rooms, where they

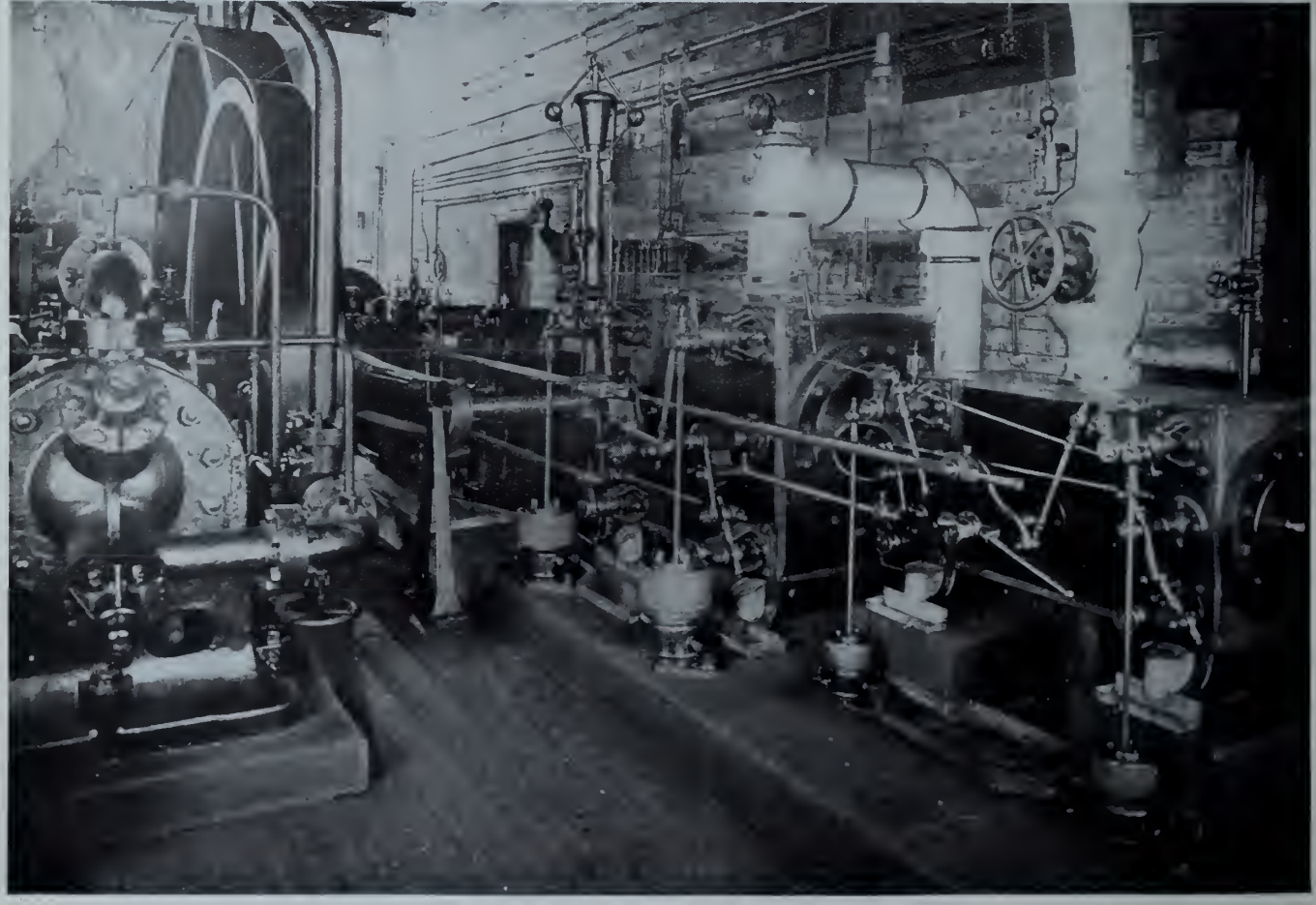


FIG. 3. 12 IN. X 24 IN. X 30 IN. TANDEM COMPOUND CORLISS ENGINE DRIVING 75-TON NIEBLING COMPRESSOR.

remain until shipped out to dealers.

The requirements of the local fish trade in crushed ice are also supplied by this company, an ice crusher being conveniently located for this purpose. It is about 25 ft. high and is operated by a 15 horse-power Westinghouse motor. An endless chain elevator raises the ice to the crusher, from which the crushed product is delivered by a chute which can be raised or lowered to suit conditions of removal.

All storage rooms requiring low temperatures are equipped with direct expansion cooling, while the fruit, cheese and egg rooms are cooled by means of cold air. All of the egg storage rooms are equipped with the Madison Cooper system of egg storage. Various items of special equipment are provided, amongst them being a Vajens improved head pro-

FIG. 8. INTERIOR OF FISH FREEZING CHAMBER AT 12 DEG. BELOW ZERO.

tector, a Westinghouse air compressor for testing piping, an ammonia distiller and purifier, and a Crosby indicator outfit.

Operative Improvements

One or two improvements effected by the writer during the past three years may indicate the possibilities available in other plants. In former days an additional freezing tank had been added to the original installation in No. 2 building, but the desirability of increasing the return suction line to the compressor had to be overlooked. It was therefore decided to increase this to take proper care of the enlarged freezing capacity. The original line consisted of 2½ in. pipe laid in a box filled with sawdust and covered to a depth of three feet. The new line was increased to 5 in. dia., and covered with nonpareil cork covering, and, in place of being laid in a box like the old pipe, was placed in a wooden pipe, such as is used for water mains. The bore of the wooden pipe was considerably larger than the outside

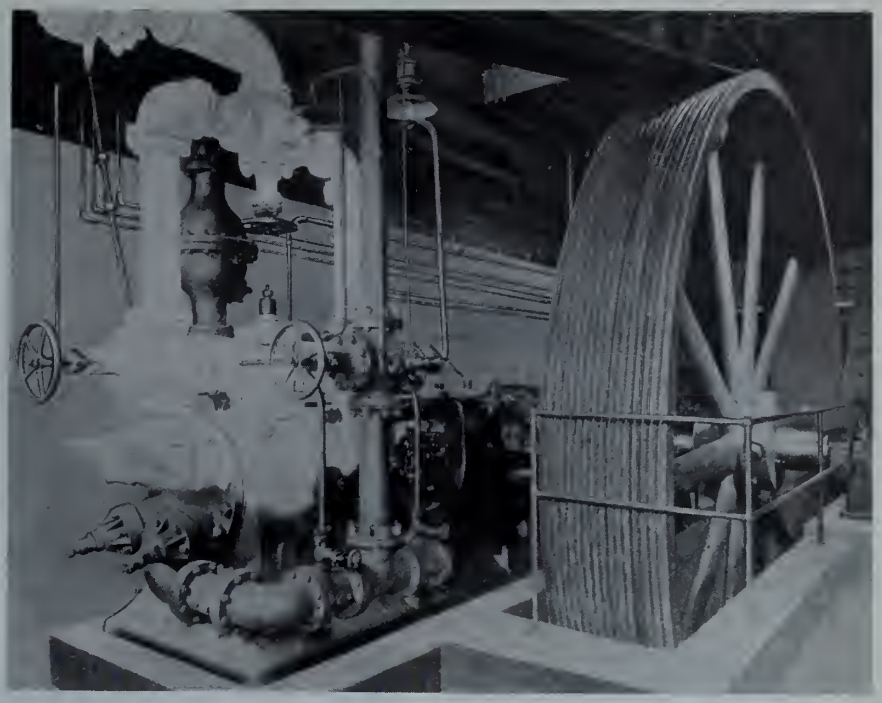


FIG. 4. 135-TON ROPE-DRIVEN NIEBLING COMPRESSOR.

diameter of the cork covering on the suction pipe, and the length was seventy-five feet. The pipe was laid to the required depth and extended under the railway tracks, being laid at a suitable inclination to insure drainage.

The lengths of suction pipe were now covered and pieces of 2 in. x 4 in. scantling were beveled on one edge and fitted to the under side of each length when it was ready to enter the wooden pipe. These scantlings acted as skids and prevented injury to the cork covering as each length was added to the suction pipe and the whole drawn further through by block and tackle. The skids kept the suction pipe in the centre of the space, leaving room all around to see through from end to end; as a good draft was always present a leak would very quickly be detected. The effect of this alteration was immediate and marked, the gauge at the compressor showing an increase of from 3 to 5 lbs. per sq. in.

General Efficiency Improvements

Attention was next given to the pipe lines throughout the plant, a considerable sum being invested in cork coverings, while traps were installed at all points where pockets were formed, allowing oil, etc., to accumulate till large quantities came over to the compressors, so that broken valves, springs and spindles were of frequent occurrence. Reduced condensation and effective

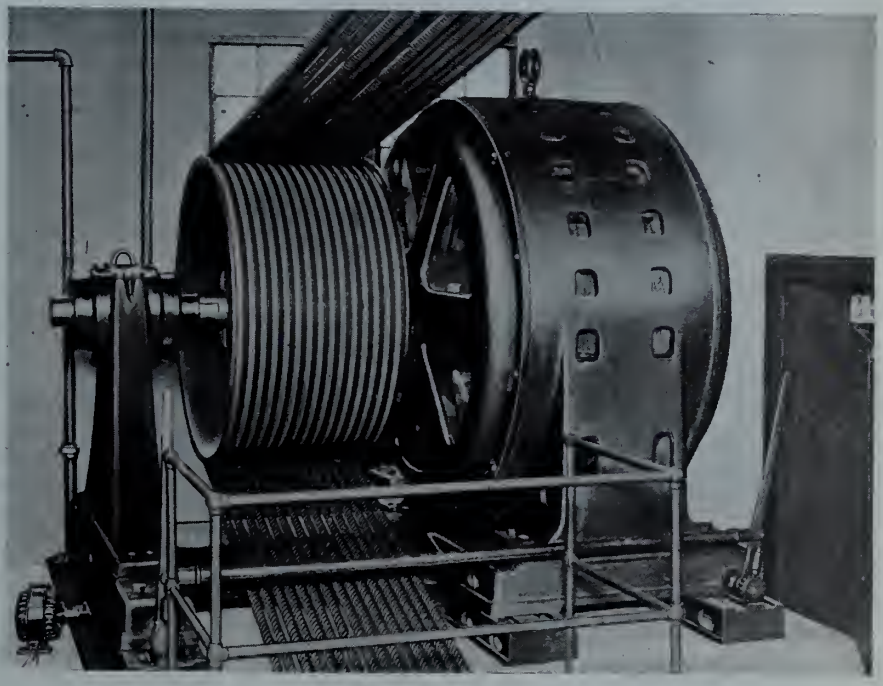


FIG. 5. 400 HORSE-POWER THREE-PHASE MOTOR WITH ROPE DRIVE.

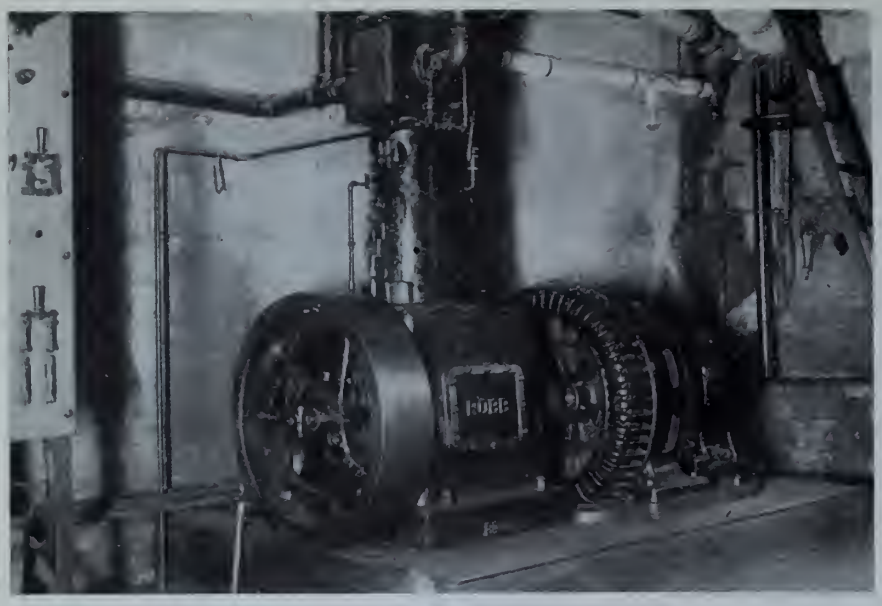


FIG. 6. ROBB HIGH-SPEED ENGINE-DRIVEN SET OF 30 K.W. CAPACITY.

drainage, brought about by the improvements referred to, resulted in only one valve spindle being broken in three years; the traps assisted greatly in the work of the ammonia purifier, the time for draining them being indicated by thawing-off taking place.

The continued growth of the fishing industry imparts a considerable degree of importance to the cold storage business, without which many allied fields of activity would be greatly restricted. The principal officials of the Vancouver Ice & Cold Storage Co. are Captain J. J. Logan, president; L. E. Harbur, manager; with A. Boggie in charge of fish freezing and storage.

FIG. 9. INTERIOR OF ROOM IN NO. 3 BUILDING SHOWING PIPING AND CONCRETE PILLARS.

FIG. 7. BABCOCK & WILCOX WATER TUBE BOILER OF 300 HORSE-POWER CAPACITY FITTED WITH CHAIN GRATE STOKERS.

ONTARIO BOILER RULES REVISION

A PROPOSAL is under consideration to revise the Rules and Regulations covering the construction and inspection of steam boilers in the Province of Ontario. A meeting was called by Dr. Riddell, superintendent of the Trades and Labor Branch of the Department of Public Works at the Parliament Buildings, Toronto, on Dec. 28, for the purpose of ascertaining the views of those interested. It is proposed to prepare a bill for presentation before the Provincial House, which will be a revision of the Act already in force. The delegation consisted of representatives of steel and cast iron boiler manufacturers, boiler inspectors, stationary engineers.

Dr. Riddell in calling the meeting to order asked for a frank discussion of the proposed rules and said he would be glad to receive any suggestions that might be helpful in the preparation of a Bill that would meet with the approval of all the interests concerned. The proposed rules which were read by D. M. Medcalf, chief boiler inspector were discussed in detail and suggestions taken down in the minutes.

At the conclusion of the meeting it was decided to send copies of the minutes to all boiler manufacturers, inspection companies, etc., who will in turn submit their views to Dr. Riddell. It was further decided to appoint a committee composed of two representatives from each of the following interests:—Steel boiler manufacturers, cast iron boiler manufacturers, boiler inspection companies, stationary engineers, boiler users, and manufacturers of fittings. The committee will confer with Dr. Riddell and will be authorized to make any suggestions which will tend to improve the present Act.

CANADIAN POWER PRODUCTION

THE generation of electricity in Canada, and its division as between domestic and export business, is dealt with in the report of the Inland Revenue Department, issued December 22. It is of especial interest because of the discussion as to exportation of electrical energy.

The Canadian Niagara Co., figuring on the basis of kilowatt hours, produced 400,521,090 units for export, and 11,178,910 for use in Canada. The Electric Development Co. exported 34,652,000, and produced for use in Canada 395,346,500 units. Other companies divided their production as follows:

	Export	Domestic
Ontario Power Co.	199,135,160	616,834,440
Ontario and Minn.	13,144,070	11,789,534
Cedar Rapids Co.	358,753,000	56,031,000
Sherbrooke Power Co.	230,820	8,605,200
Maine & N.B. Co.	3,075,893	242,437
Western Canada Co.	11,937,700	60,468,020
B. C. Electric	330,626,680	470,689

On an examination paper the following question was asked: What is steam?''

One engineer said: ''Steam is water in terrible sweat.''

Power Transmission Section

FRICTION CLUTCHES—II.*

By W. G. Gass.

IN our December issue a resume was given of the different types of friction clutches manufactured, examples of which are to be found installed in lesser or greater number as part of the transmission equipment of general industrial and metal-working plants. The driving surface feature was discussed at some length in the same issue.

Clearances

Clearance is the main difficulty in the general run of clutches, and the smallness of it is the cause of a considerable amount of wear when running out of gear. In all cases where the setting-up is done by screws, the clearance between the driving part and the driven is a relatively small amount. The cone gives the largest amount of any, and on that score alone is the best. In segment clutches, both inside and outside band clutches and plate clutches, it is a very serious problem. In the majority of these, where a screw is used, the usual amount of rotation of the screws is about ⅛th of a revolution, and if screws of say ¼ in. pitch are used, right and left hand, the movement given to the segment is 1-16th of an inch—1-32nd on each side, and that represents the clearance when the clutch is out of gear; the actual clearance is less than this owing to the shape of the segments.

Setting Up Gear

In all cases the action of setting up a clutch is the conversion of a sliding movement along the shaft carrying the clutch into a pressure between the clutch surfaces. This may be properly divided into two portions, the first that which is in the clutch itself, and the other by which the power for operation is applied. In the majority of clutches the locking and concentration of power obtained by the toggle motion is the one mostly adopted, and when once set up has no tendency to slip back. It requires in every case an adjustment by means of a screw which can be set so as to bring the levers in the correct position to give the requisite pressure on the surface.

*Read before the Manchester Association of Engineers.

In most of the internal and external segment and band clutches the adjustment is obtained by moving the main nuts a portion of a revolution and relocking—the nut having a serrated rim with a locking pin. In plate clutches it is generally done by using the adjustment screw at the point where the pressure to the plates is applied. In others, the forcing of the surfaces in contact is done by a wedge, having at its larger width a parallel portion which takes the end thrust off when the clutch is set up. The wedge is flat in some and circular in others.

With both the toggle point and the wedge, a sliding block is necessary to transmit the power from the stationary lever to the rotating shaft carrying the cluch. In the majority of cases the power is applied to the clutch to set it in gear, but, in others, the power is applied to release it or put it out of gear, the clutch being kept in gear by means of springs. Motor car clutches are the most common examples of this kind. For general machine driving, where a rapid movement is required for operating the clutch, a lever is usually employed, and if the leverage be sufficient, is quite satisfactory. It enables the power to be applied quickly and as quickly released, and where it is desired to give a slight movement to the machine, and also where the clutch is put in gear and released many times. Where a clutch is in gear for long periods, a screw and quadrant is mostly used. This is as generally fitted to internal combustion engine drives. It gives an easier starting movement because the pressure can be more gradually applied, but it is much slower both at starting and releasing. Where the lever is used, particularly on a heavy clutch, it requires a strong pull on the part of the attendant to put the clutch in gear. The trouble with all setting-up gears is the wear on the pins and lost motion due to clearance in bearings.

Pressure on Working Faces

This is the crucial point in the efficiency of any clutch and its power to drive, for unless the necessary pressure exists between the frictional faces the clutch cannot transmit its power, and it is here where so much trouble arises in the use of any form of friction clutch. The power of any clutch is of course dependent on the co-efficient of friction between the surfaces, and whether they are dry or lubricated, and it is this factor which so materially affects any formulae for the power of a clutch. The co-efficient of friction varies greatly with the state of the surfaces, and, after the surfaces become glazed the power of the clutch drops in unison.

It is usually considered that if an actual pressure of 50 lbs. per square inch can be put on the surfaces it is as much as is desirable for good working conditions; but, if for any reason a less pressure is put on than that required to transmit the power, a clutch will, if it begins to slip, grind itself away quickly, and in the spring centre type grind away all the available spring in the metal. On looking at the action of the toggle joint it will be seen that the travel of the portions of the clutch being set up is very slight at the end of the movement, when the thrust link of the toggle is approaching the vertical. Pins are essential, and, in spite of all that can be done, will wear, so that if a clutch is set up correctly a very small wear on the pins and links of the toggle will rapidly reduce the effective pressure of the faces, even without taking into account the wear on the frictional surfaces.

It is, therefore, very necessary to keep a watch on a clutch to see that any wear which may take place is followed up, if the life of a clutch is to be as long as it ought to be. Where the pressure on the surface is due to springs, and these usually are in direct thrust, then they will follow up a considerable amount of wear themselves. It appears from this as though springs were the best, but they are only good where conditions are suitable, and this is not generally so for driving machines. The remarks about wear apply equally to wedge setting up surface. The power transmitted is proportional to the speed of rotation, and a clutch which will transmit 10 horse power at 100 revs. will of course transmit 50 horse power at 500 revs.

Lubrication

In clutches, as in everything else, lubrication is of the greatest importance,

and more particularly where the clutch is running idle for a considerable part of its time. If the outside portion of the clutch is the driven part, it runs on the shaft and may have to be stationary while the shaft rotates in the clutch bushes; or, if the outside is the driver it has to run loosely on a stationary shaft. This is a fruitful source of trouble with many clutches, and the lubrication of these bushes requires the closest attention, both in design and on the part of the attendant. If the driven portion has to be stationary while the shaft runs in it, there is a tendency for the shaft to wear a groove in the bush, and, when this starts, it rapidly grows worse as this part always seems to stop at the same point and be worn oval; while if the driving portion has to run loose on a stationary shaft, the bush wears larger and affects the clearances, even sometimes becoming so bad that the friction surfaces never run clear and are always rubbing. When in gear the lubrication is not required, and the oil is liable to be driven out of the bearing surfaces and so be missing when wanted.

In starting up any friction clutch a certain amount of rubbing takes place, and when two metal surfaces rub on one another fine particles of metal are given off. These, in an enclosed chamber, cannot get away and so become mixed with the lubricant, and form an excellent abrasive which does not increase the life of the parts. Another peculiarity of lubrication in the case of plate clutches is that where the resistance to the idle clutch is not very great, if the oil becomes thick the plates adhere because all the air is driven out between them, and the resistance may not be able to make the clutch stop. Springs between the plates have been tried to get over this, but the results have not been very satisfactory. Excessive lubrication also reduces the driving power materially. Solid grease has much to be said on its behalf for lubrication of clutch hubs, but it is often difficult to employ it satisfactorily.

CANADA'S 1916 COAL OUTPUT

THE Dominion Department of Mines has received from the principal coal operators in Canada returns of their production for ten months, supplemented in most cases with estimates for November and December.

On the basis of the record available, it is estimated that the total production of coal in Canada during the calendar year 1916 will approximate 14,365,000 short tons (equivalent to 12,825,892 gross tons). The estimate is believed to be fairly close for Nova Scotia and British Columbia. In Alberta, however, there are so many small operators that final returns may show a wider variation from the estimates now made. By provinces the estimate is as follows, the figures for 1915 being included for comparison:

	1915.	1916.	Inc.
N.S.	7,463,370	6,950,000	*513,370
N.B.	127,391	135,000	7,609
Sask.	240,107	260,000	19,893
Alberta	3,360,818	4,400,000	1,039,182
B. Columbia..	2,065,613	2,620,000	554,387
Yukon	9,724	.....	.....
Total	13,267,023	14,365,000	1,097,977

*Decrease.

The 1916 production exceeds that of the two previous years, the increase over 1915 being about 8 per cent. Nova Scotia is apparently the only province that has not made an increased production, the falling off in this province being a little less than 8 per cent. The increase in Alberta is nearly 32 per cent., and in British Columbia nearly 27 per cent. The production in New Brunswick, Saskatchewan and British Columbia is the highest on record. No estimates are available yet as to the Yukon output.

AIR CYLINDER EXPLOSION

AN alarming explosion of a compressed air cylinder worked in connection with a large gas engine has come to our notice, says *Vulcan*, and as so many of these high-pressure cylinders are now in use for starting purposes, the facts of the case are of interest.

It is sometimes asserted that air receivers are not liable to corrode or develop other defects on the inside, and, apparently, in accordance with this view many receivers are made without provision for internal examination. Experience with these vessels, however, shows that there is sufficient moisture in the air to cause serious corrosion, and that this is often aggravated by grease deposited from the compressor. For this reason facilities should always be afforded in air cylinders for proper periodical cleaning and examination on the inside. The ends of such cylinders also should

LAMINATIONS IN EDGE OF FRACTURED COVER.

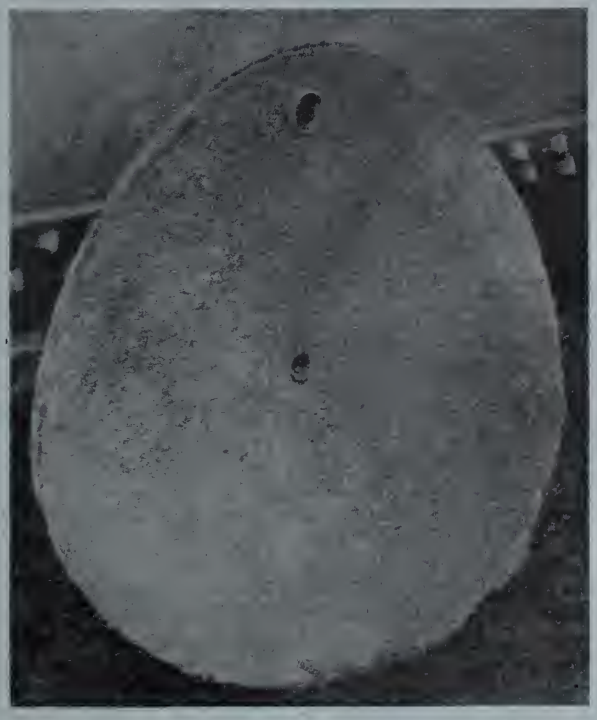
be of ample strength and well dished, unless otherwise strengthened by stays.

The cylinder in question was worked at a pressure of about 200 lbs. per square inch, and was made of iron plates about 3/8 in. in thickness originally. The ends were nearly flat and the material, judging from the quality of the end which failed, was of very inferior quality. This

END OF AIR CYLINDER SHOWING FRACTURE.

plate was badly laminated for nearly its whole circumference and also corroded, and owing to the panting action which inevitably occurred with a circular flat plate under the working conditions, grooving was set up at the root of the flange attaching the end to the cylindrical body and eventually weakened the end to such an extent that it was blown out. The explosion was a violent one, the top end of the cylinder being thrown through the roof and into a field about 100 yards away. The windows of the engine house were damaged and the engine attendant had a narrow escape.

Air cylinders of this type intended to work at high pressures should be very carefully designed. The material should be of the best mild steel of ample strength, and for a diameter of 2 ft. the size of the cylinder in question, the ends should have been about ½ in. thick and dished to a radius not less than the diameter of the receiver, which in the present instance would have been about 4 in. to 5 in., whereas the actual camber of the ends was only about ¾ in. Where flat or nearly flat ends are used the plates should be adequately stayed with bolts or other means. Should an air receiver be too small to fit an ordinary pressed steel manhole and cover, hand or side openings should be provided near each end, so that the flange portion of the crown plates can be examined periodically for grooving or other defects. Air cylinders should also have a drain at the lowest point for washing-out purposes, and, of course, a suitable safety valve and pressure gauge.



AIR CYLINDER COVER FOLLOWING EXPLOSION.

BOILER INSPECTION REPORT, DEPT. PUBLIC WORKS PROVINCE OF ONTARIO

THE enormous increase in the cost of steel since the outbreak of the war has affected to a quite considerable extent the manufacture of boilers in Ontario as elsewhere by reason of the necessary increase in the selling price. This increased cost of new boilers has created a great demand for secondhand boilers—not altogether on account of cheapness for high prices are being paid—but by reason of their being more or less immediately available. Many old and discarded boilers which in normal times would be sold as scrap or left rusting in vacant places around our factories have been cleaned and painted and put on the market for sale by boiler dealers, a circumstance calling for extra vigilance as far as inspection goes.

A slight alteration has been made in the Steam Boiler Act, section 2, subsection D. which formerly read:—

"A portable boiler rated at 25 horse power or under, or a boiler used exclusively for horticultural or agricultural purposes." The words "rated at 25 horse power or under" have been omitted. This change in the Act gives jurisdiction over portable boilers used in public places in conjuction with contractors equipment, etc. Boilers of this kind formerly were not built from registered designs and were exempt from provincial laws. The fact that those boilers are often used in close proximity to hundreds of people is good reason why their designs should be of the most approved type, and also why they ought to be inspected annually.

It will be noted from the list of inspections that in addition to boilers, a number of air tanks have been examined during the past year. This inspection work was made at the request of the owners of these vessels and the customary fee of $5.00 per tank was paid by them. The safe working pressures were determined from the rules governing the construction of steam boilers, and the same certificates as issued for used boilers were made out for these vessels.

During the past year ten boilers have been inspected for British Columbia. Arrangements were made during 1915, whereby the inspection of all stationary boilers built in Ontario for British Columbia would be carried out by Inspectors of this branch. Some trouble was previously experienced by manufacturers on account of their boilers being re-examined on arrival at their destination, and sometimes the safe working pressure was reduced on account of defects in the workmanship. The boilers examined during the past year have been accepted by the British Columbia authorities without being penalized in any way. During normal times the number of boilers built in Ontario for British Columbia would of course be much more than last year's total.

For some time past, and more especially since the fatal steam valve explosion at the Greey Foundry, Toronto, the work of surveying and registering high pressure pipe lines has been undertaken. The accompanying data summarises the inspection work carried out during the year ended October 31, 1916.

Drawings and Specifications Surveyed and Registered

Boilers	97
Boiler fittings	78
Pipe lines	31
Pressure tanks	4
Superheaters	1
Drawings returned to manufacturers for correction	17
Registered boilers inspected during construction	313
Plates examined	1415
Plates rejected	16
Registered boilers inspected by Insurance companies in the United States	35
Registered boilers inspected by Insurance companies in Great Britain	4
New boilers inspected during construction for British Columbia	10
Used boilers inspected in Ontario	612
Steam drums inspected in Ontario	21
Steam plans inspected in Ontario	1
Pipe lines inspected in Ontario	4
Used boilers inspected and condemned	23
Class "A" certificates issued for new boilers	348
Class "B" certificates issued	

VOLTAGE distribution curves plotted from the bar-to-bar voltage readings taken around the commutator of an armature turning in a magnetic field will indicate the mode of the flux distribution in the air-gap. When the armature carries no current, the flux distribution will be uniform and the curve will be symmetrical on both sides of the maximum. The presence of armature current, however, will distort the flux and make its distribution non-uniform, under which condition the curve will have a sharper slope on one side of the maximum than on the other. This means that across the commutator bars that correspond to the steep slope part of the curve a much greater potential difference will be present than across the same number of bars anywhere else on the commutator. If the conditions are such as to make this discrepancy exceed a certain value, sparking or flashing, or both may result.

UNIFLOW STEAM ENGINES FOR STEEL MILLS*

By W. Trinks.**

THE trend of power supply in iron and steel plants has been to electrify every machine, up to and including the main rolls, and to concentrate the power generating apparatus in a central power house containing steam turbines in regions of cheap fuel, and gas engines with an auxiliary steam turbine for overloads, in regions of expensive fuel. Into this evolution stepped the uniflow engine, which promises or threatens (depending upon the viewpoint), to change the march of events. The iron and steel plant electrical engineer is particularly interested in this problem because a change would deeply affect his work. For him the two following possibilities are of importance:

The uniflow engine may find a place in the works power plant, or else it may drive rolling mills directly, doing away with the double conversion of mechanical into electrical power in the central station and back again into mechanical at the mill. In Germany the uniflow engine has, in many places, been used for direct rolling-mill drive in preference to electrical drives. The question to be studied is, then, what has been accomplished on this continent in the development of this type of engine, and what is the outlook for the future?

Historical Features

The history of the uniflow engine begins in 1907. In that year Professor J. Stumpf, of Charlottenburg, Germany, made his designs and applied for patents. The characteristic part of the Stumpf engine, as is perhaps already well known, is the cylinder with steam admission at the ends, discharge in the center, and steam jacketed heads, as shown in Fig. 1. The idea of steam admission at the ends in combination with central discharge is old and was patented by Todd in England in 1885, but the fact that the idea remained wholly unused until Stumpf proved that it was useful when coupled with jacketed heads and a partly jacketed barrel, credits Stumpf as the inventor of the uniflow engine from the viewpoint of the critical historian.

In 1907 Professor Stumpf clearly recognized the thermal advantages to be gained from the unidirectional flow of steam through the cylinder. In the summer of that year he fully explained his view upon the subject to the author of this paper at Charlottenburg, Germany. At that time the drawings of the experimental uniflow engines were well in hand. From 1907 to 1911 the evolution of that type of engine was limited practically to Austria and Germany. In 1911, Professor Stumpf published his well-known book on the uniflow engine, and bitter literary controversy on the merits or demerits of the Stumpf engine followed. In the same year American engineers began to take notice of the Stumpf engine and, one by one, the C. & G. Cooper Co.; the Nordberg Mfg. Co.; the Mesta Machine Co.; the Skinner Engine Co.; and the Ames Iron Works took up the building of this type. A great deal had to be learned by these firms, and some of the experience was paid for quite dearly. At the present date, the period of experimenting is practically over, and the time is ripe for a review of the situation.

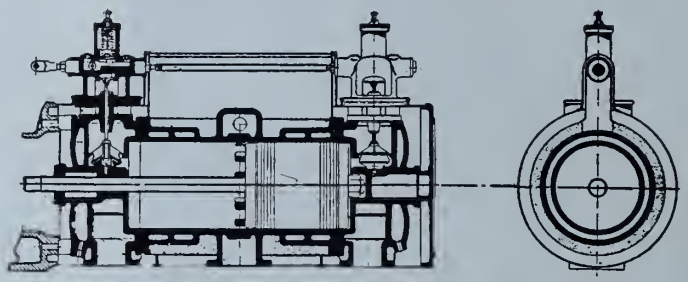


FIG. 1. LONGITUDINAL AND CROSS SECTIONS THROUGH STUMPF UNIFLOW ENGINE CYLINDER.

The principal claims for the uniflow engine are economy, simplicity, reliability and freedom from attendance. Let us consider these features in the order mentioned and then judge whether we can profitably use the Stumpf engine in our work.

In the steel works power plant this engine will have to compete with the gas engine and with the steam turbine. The gas engine was 7,500 to 9,000 British thermal units per indicated horse-power hour, whereas the uniflow engine, running condensing, uses from 11,000 to 13,500 British thermal units in the steam, and more in the fuel gas, depending upon the boiler efficiency. There is, in consequence, little hope of replacing the gas engine by the uniflow engine.

Steam Turbine Comparison

When we come to a comparison between the engine and the turbine, variation of steam pressure and of back presure makes it advisable to leave the British thermal unit basis and to introduce Rankine cycle efficiency, which means the ratio of the work actually produced from unit weight of steam to the work which could be produced by the same weight of steam passing through the Rankine cycle. From a great number of published tests made on the very best turbines, the author has formed the following averages for condensing operation:

Size of turbine, kw.....	500	1,000	2,000	5,000	10,000
Rankine cycle efficie'y	0.62	0.66	0.71	0.77	0.82

(Referred to brake h.p.)

For non-condensing operation he values are much lower.

For the Stumpf engine, data furnished by the Stumpf Uniflow Engine Co., tests made by the author, and data from Ames Iron Works and from the Cooper Co., indicate the following efficiencies:

Size of engine, kilowatts.....	300	600
From 3 lbs. per sq. in., back pressure above atmosphere down to about 23 in. vacuum.		
Efficiency:		
Saturated	71	74
100 degrees superheat	75	77
200 degrees superheat	78	79
For high vacuum (about 27½ in.):		
Saturated	58	62
100 degrees superheat	62	65
200 degrees superheat	66	68

The values may vary somewhat to one side or the other, but the general tendency is apparent. For non-condensing operation, at 100 degrees superheat, with moderate vacuum, and for sizes up to 1,000 kilowatts, the uniflow engine is more economical than the turbine. It will, therefore, find a place in comparatively small power plants, and in locations where 28 inches of vacuum or better is not obtainable. It will also be preferred for generating direct current, because turbines for the generation of direct current, when direct connected, are too slow for best economy. If they are to operate at economical speed, gears must be introduced.

*From a paper presented at the 10th annual meeting of the Association of Iron and Steel Electrical Engineers.

**Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

Limited Field in Steel Works

Evidently, the uniflow engine will have a very limited field in the steel works power plant. Turning to the second application which interests us, namely, the driving of rolling mills, we find a changed condition. Let us for the sake of clearing up doubts, compare the uniflow engine with electric drive, and with older type of duoflow engine. In comparison with electric drive, the steam engine does away with the electric generator, the switchboard, the transmission line and the motor, but it takes undesirable piping into the mill. The elimination of the electrical part means that we must compare the Rankine cycle efficiency of the engine to the Rankine cycle efficiency of the turbine, including generator, transmission line and motor. Allowing the high efficiencies of 92 per cent. for the generator, 98 per cent. for transmission line and 92 per cent. for the motor, we must multiply the turbine efficiencies by 0.83 for comparison with the direct-connected engine.

This procedure furnishes the following:

Size of turbine, kw.	500	1,000	2,000	5,000	10,000
Rankine cycle efficiency:					
Referred to motor shaft	50	54	59	64	68
Referred to mill shaft..	47	50	55	60	64

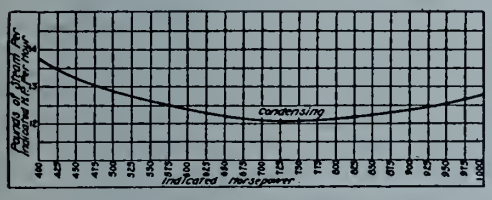


FIG. 2. WATER RATE LOAD CURVE OF ORDINARY COMPOUND ENGINE.

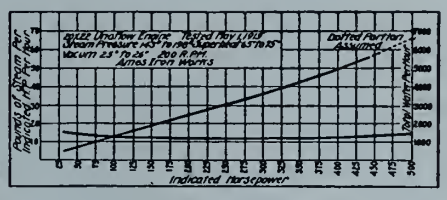


FIG. 3. WATER RATE LOAD CURVE OF UNIFLOW ENGINE.

The lower row of figures was obtained by multiplying the upper row by 0.965, this figure taking care of the efficiency of two speed reductions from the motor to the mill. A study of the resulting values shows that the uniflow engine is ahead of the electric drive, unless the steel plant is so large that turbo units of over 8,000 kilowatts capacity can be installed.

The economy of the uniflow engine compared to that of the steam-turbine-electric drive, taken by itself, is not enough better to explain why the uniflow engine should fare differently from the compound engine. The Rankine cycle efficiency of a good compound engine is practically the same as that of the uniflow engine, but there is one difference. To obtain that high efficiency, the compound engine must have a small high pressure cylinder; but the small size of the latter means a small overload capacity, and quick departure from the best efficiency for comparatively small changes of load.

Compound Engine Comparison

Fig. 2 shows the water-rate-against-load curve for a well known compound engine. Comparison of this curve with the typical water rate curve of a uniflow engine, Fig. 3, shows the difference to be very marked. Mill loads are notoriously variable, because small variations in draft, temperature of steel, velocity of rolling, etc., cause disproportionately great changes in resistance. It is not possible to exactly foretell what the load will be, and it is therefore of the utmost importance to secure a drive which permits over or underloading without serious change of economy. The uniflow engine, and the electric motor hitched to a large central station, both fill this requirement.

The old type simple duoflow engine, the old reliable standby of the rolling mill for over 50 years, cannot be considered here. It is so wasteful, that its low price is more than offset by increased cost of boiler house equipment, not to mention the continuous cost of fuel and water. It retained its place in the mill a long time, due to its simplicity, but was replaced here and there by the compound engine on account of its wastefulness. The uniflow engine combines the simplicity and overload capacity of the simple engine with the economy of the compound engine; it has the added advantages that its overload capacity is even greater than that of the simple engine and its economy is sustained over a greater range of load. Finally, it has very few moving parts and takes up much less floor space than the compound engine.

Variation in back pressure naturally affects the operation of the uniflow engine. However, the vacuum may, with 4 per cent. clearance, vary from 19 to 27 inches of mercury without unduly high compression, or pounding, due to lack of compression. If the vacuum fails altogether, clearance is automatically added, to keep the compression down.

Uniflow Engine Development

A great deal has been written on the reasons for the economy of the uniflow engine; nevertheless the author will try to present the underlying facts again in as concise form as possible. The secret of the economy of the uniflow engine lies principally in reduction of internal cylinder condensation. In the duoflow single expansion engine, cylinder condensation is so great, that a very great free expansion loss must be allowed for best economy (or rather for minimum wastefulness). In the compound and triple expansion engine, cylinder condensation is reduced so that the free expansion loss can also be reduced, but mechanical losses due to the passing of the steam through so many valves becomes great. In the duoflow engine, cylinder head, cylinder barrel and piston head are alternately heated and cooled by live steam and exhaust steam sweeping over them and wiping heat "on and off".

In the uniflow engine, only the piston head has heat wiped off during the extremely short period of exhaust, the steam near the place of entrance of live steam being at rest like the fixed end of an expanding coiled spring during exhaust, and like that of a compression spring during compression. Besides, the cylinder head and part of the barrel are steam jacketed, and steam jacketed surfaces are cooled very little by stagnant steam. It may be remarked again that the mere provision of a central exhaust does not bring about a successful uniflow engine; the steam jacketing of the heads and of part of the barrel must go with it, to produce the thermodynamic superiority over the duoflow engine.

In the duoflow engine, long compression means increased steam consumption, principally, because the steam temperature exceeds the cylinder (or piston) wall temperature a longer time than it would with shorter compression. In the Stumpf uniflow engine the steam which is being compressed is in contact with progressively hotter surfaces, with the exception of that of the piston, and the steam temperature never rises very much above the wall temperature.

The second reason for the economy of the uniflow engine lies in the enforced or compulsory tightness Steam cannot leak from the live steam space to the exhaust. If the inlet valves are leaky to any exent, the compression rises so quickly that the inlet valves clatter and give notice to the engineer that something is wrong.

In comparing test data with calculation results, I have obtained very good results by using Heck's formula for the internal condensation or missing quantity, but I substitute instead of his constant C the value

$$C - \sqrt{\frac{\text{°F. superheat}}{4{,}500}}$$ for duoflow engines, and $$0.45\ C - \sqrt{\frac{\text{°F. superheat}}{10{,}000}}$$ for uniflow engines.

Uniflow Engine Economy

The development of the uniflow engine in the United States has been slow, probably because it did not fit into the general trend of changing from reciprocating to rotating machinery, and because it is of foreign origin. It began in a small way in 1912. The C & G. Cooper Co., Mount Vernon, O.; the Nordberg Co., Milwaukee, Wis., and the Mesta Machine Co., Pittsburgh, began almost simultaneously to build experimental engines . All three firms moved cautiously and equipped their engines with Corliss gear. All three found out that the Corliss releasing gear, in its usual form, is not ideal for

the uniflow engine, because the cut-off is so short, because modern plants carry high pressure with superheat, and because the pressure drops so fast after cut-off, that the valve becomes unbalanced too quickly for the ordinary design and size of vacuum pot. In consequence, the Mesta Co., and the Nordberg Co. switched over to poppet valve gears, while the Cooper Co. adapted its Corliss gear and vacuum pot to the new conditions.

The smaller sizes of uniflow engines have been developed by the Ames Iron Works, Oswego, N.Y., and by the Skinner Engine Co., Erie, Pa. The Ames Iron Works, from the very beginning, adopted poppet valve steam distribution, with shaft governor drive. This design is very well adapted for small engines up to 400 or 500 horsepower, and is very successful. For larger sizes and high steam temperature it is not so well adapted, because the difference in expansion between the valve rod and the cylinder becomes too great and disturbs steam distribution. For poppet valve engines above 500 horsepower the lay shaft drive is preferable.

In the sizes built by the Ames Iron Works, a self supporting piston, guided at the crank end only, is said to be satisfactory. In larger sizes this same design leads to a great deal of trouble. On account of difference in expansion, the piston must fit very loosely in the cylinder. The guiding of the piston by the crosshead is very imperfect. The piston, therefore, wobbles around in the cylinder, riding now on one spot, then on another, never wearing itself in, but rapidly wearing itself out. In large engines of German design, a tail rod guide has been provided, not so much for the purpose of carrying the piston, but mainly for the purpose of guiding it, so that it will always touch the cylinder in a large surface. American engineers have gone one step further and have made the piston rod strong enough to carry the piston.

Early Troubles

The early part of the practical development was thorny. Cracked cylinders, heads and bed plates caused trouble; valve gear troubles and regulation troubles had to be overcome, pistons and cylinders wore too rapidly; but the problems have all been solved and the future promises to be free from any obstacles whatsoever. Whatever troubles were experienced, naturally appeared more forcefully in the larger sizes, with the result that the smaller sizes, developed by the Ames Iron Works and the Skinner Engine Co., have made more progress in numbers than the larger sizes. It can safely be said that the uniflow engine to-day is as reliable as the simplest engine of the duoflow type. Additional steam consumption charts may be appreciated. To the scientific engineer they do not mean as much as Rankine cycle efficiencies, but habit has led many of us to think in pounds of steam per horsepower-hour. Consequently, Fig. 3 is given showing steam consumption of various types and sizes of uniflow engines.

PIPING FOR STEAM GENERATING PLANTS

It is of particular interest, in connection with this article, to note that a separator or receiver of approved type and of suitable size, installed in the pipe line as near the engine as possible, decreases or entirely prevents vibrations that might otherwise be transmitted to the steam piping by the continued opening and closing of the engine valves—which tends to cause pulsations of steam in the pipes. The steam in the receiver acts as a cushion to absorb the shocks caused by the quick cut-off in the steam chest of the engine.

Vibration in steam pipe lines is not only a source of annoyance, says the *Travelers' Standard*, but it is also positively dangerous, provided it is of sufficient intensity and is continued during a considerable period. Given the proper conditions, the pipes may be loosened from their supports by the vibration, the supports themselves may gradually pull away from the walls or beams to which they are secured, and other damage may be caused.

Causes of Vibration

The operation of the engine valves is not the only cause of vibration in the pipe lines. Vibration may also be due to the sudden changing of the direction of the steam flow where short-turn tees and elbows occur, and by variations in the velocity of the steam flow in different parts of the piping system. Steam boilers also, may, under certain conditions, transmit vibration to the piping which is connected to them. When the plant is operating at its fullest capacity, or with an overload, and the steam space in the boilers is insufficient, the pressure is quite likely to diminish rapidly. This will cause the water in the boilers to boil and bubble violently, with the result that the boilers will vibrate considerably.

If the engine-governor or the valve mechanism is out of order or improperly adjusted, the engine may be caused to vibrate, and the vibrations may be transmitted to the piping. It has also been observed that vibration and the accompanying strains are specially pronounced at intervals, in plants where several high speed engines are in operation at the same time. This may cause the pipes to vibrate in unison a part of the time; but the synchronism is likely to fail and each pipe will then vibrate independently of the others.

Vibration Prevention

After the cause of vibration has been determined in any particular case, a cure for the trouble will usually suggest itself. In installing a system of steam pipes, it will save much subsequent annoyance, expense, and perhaps danger to take all possible precautions against the propagation and transmission of vibrations which may in any way be due to the engines, boilers, or piping. A suitable separator or receiver should be provided and installed as near the engine throttle as possible—one having a capacity three or four times that of the high-pressure cylinder of the engine being not any too large. The pipes should be supported and anchored properly, not losing sight of the fact, however, that a certain amount of flexibility is essential to guard against dangerous contraction and expansion strains (which will be referred to later), caused by changes in temperature; long-turn bends should be used wherever possible; and the entire system should be proportioned so as to make the velocity of the steam as nearly uniform as possible in all the pipes.

Well designed boilers of ample capacity are requisite in order to secure satisfactory results, and the necessity for forcing them should be avoided. Engine-governors, valves, and other essential parts should be kept properly adjusted, not only to prevent vibration, but also to guard against troubles of other kinds which would be almost certain to result from neglect in this respect.

Expansion and Contraction

Pipes in a steam piping system expand as they are heated by the entering steam, and contract as the temperature falls when the steam is shut off. The co-efficient of expansion is so small that the increase in the circumference of a pipe due to the application of heat is of no consequence. In a large plant, however, there may be pipe lines several hundred feet in length, and then the effect of alternate expansion and contraction throughout the length of the pipe may have an important bearing on the safety and economy of the plant. Unless proper means are adopted to relieve the strains caused in this way, the pipe joints are likely to open and leak, fittings may be broken, or the pipe itself may rupture at its weakest point.

These dangers may be eliminated by firmly anchoring the pipe at a suitable number of points, the number depending upon the length of the pipe. If the pipe is a comparatively short one (say up to 50 feet or thereabouts), it will usually be sufficient to anchor it in the middle of its length, allowing the two ends to expand away from the anchor. This method is not suitable for longer pipes, however, and as previously stated, several anchorage points must be selected, the number depending upon the length of the pipe. The anchors and supports for the pipes should be located as near as possible to the flanges which join the various sections of the pipe line, so that those parts will not be subjected to undue stresses. The points where the pipes connect to boilers, engines, and other apparatus should also be protected as adequately as possible against expansion and contraction strains.

The expansive force of heat acting upon a steam pipe is practically irresistible and it is therefore necessary to make some special provision to care for the expansion of the section of pipe between the two points at which it is se-

cured. This is usually best accomplished by the use of expansion loops or bends. Whenever possible, the bend should be installed in a horizontal position—that is, in the same plane as the main pipe; but if for lack of room or for any other reason it is necessary to place it with the loop or bend extending upward from the main pipe, a drip should be connected to the main pipe on each side of the expansion bend. These expansion bends should have a radius not less than six times the diameter of the pipe, and the flexibility of them will be increased if the radius is made still larger. Right-angle pipe bends should be used wherever possible in place of elbows, to aid still further in eliminating expansion and contraction strains.

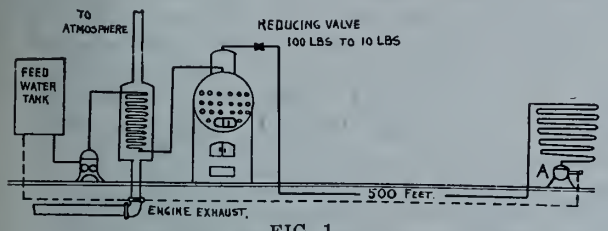


FIG. 1.

Unless great care is taken when installing pipe lines it may be necessary to force some of the pipes into position to make the joints. Strains caused in this way should be avoided, because they are likely to be magnified when the pipes are heated, and to cause serious trouble. The workmanship should be of the best, and the pipes and fittings should be of the highest quality and carefully selected. Pipes and fittings having crooked or defective threads, and pipes with improperly fitted flanges should be discarded.

OTHERS' MISTAKES AND MY OWN

By R. Manly Orr.

SOME time ago an incident occurred which impressed on me the necessity of every engineer understanding the why and wherefore of the different jobs he is called on to perform. It occurred at a certain plant of which a friend of the writer has charge, a diagrammatic layout being shown in Fig. 1.

A new manager arrived on the scene one day, and happening to see trap A discharging very hot water to the atmosphere, ordered it to be connected back to the boiler-feed tank, as indicated by dotted line. The engineer, eager to carry out the orders of the boss and feeling half guilty at not having suggested the saving himself, set diligently to work, and when the writer happened to look in one day, had dug a long trench across the mill yard, cut through a plank roadway, and laid out several bundles of 1 in. galvanized pipe ready for connecting up.

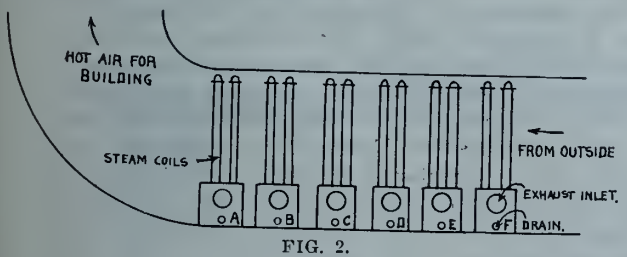


FIG. 2.

"What are you doing?" I asked. He told me.

"Water costs you nothing but pumping here. What's the idea?" I rejoined.

"The heat," he replied. "The boss says all that heat running to waste represents dollars in fuel, and he wants to save it by putting it back into the feed water. I tell you he's a close one."

Not Time to Laugh

I wanted to laugh, but I remembered some of my own fool mistakes, so looked serious and interested instead, finally remarking: "That won't make the water from the heater to the boiler any hotter, will it?"

"N—no," he replied, "but it will save-s-some exhaust steam."

"I see," said I, slowly. "It will take less exhaust steam to heat the feed water and give you so much more exhaust to shoot up into the air."

He looked at me a moment and then burst out laughing—and I helped.

The job was finished and put into service and my friend told me afterward that the boss came in several times and put his hand on the suction pipe of the pump, which was hotter than before, remarking, "That's fine."

Having admitted making mistakes himself, the writer will at least mention one.

At one time the plant of which he had charge was heated by exhaust steam, the entire amount available being passed through the coils shown in Fig. 2. During the coldest part of winter, the supply of exhaust steam was not sufficient to keep the building warm, so the superintendent ordered two of the banks of coils to be changed from exhaust to live steam. The writer thereupon put banks E and F on live steam and thought no more about it until some months later when studying a condenser catalogue, the "counter-current" principle was brought to his notice, causing him to realize his error in putting live steam into coils E and F instead of A and B. The connection was immediately made, resulting in hotter air with less live steam.

AUTOMATIC BOILER FEED-WATER REGULATORS

IN order to have satisfactory and safe operation of a steam boiler, it is absolutely necessary that the water level be maintained within certain limits. If it be possible to accomplish this by means of some reliable mechanical device, instead of relying upon the constant attention of a fireman or water-tender, who is human, and therefore liable to make mistakes, the advantage is apparent, from the point of view both of safety and of economy of labor. As a result, a number of different devices have been developed, whose object is to control automatically the flow of feed water into a boiler, so that the water level will be maintained within certain predetermined limits. These devices are called automatic boiler feed-water regulators and they seem to have a very high degree of reliability. Many advantages are claimed for them besides those already indicated, chief among which is increased boiler efficiency due to their use.

If, in addition to the automatic feed-water regulator a high-and-low-water alarm is installed, the danger of high or low water is reduced to a minimum, for, in case the automatic regulator fails to operate properly, the fireman's attention is called to that fact by the high-and-low-water alarm, and he can then control the feed by hand until the trouble with the regulator has been overcome.

INTERNAL COMBUSTION ENGINE LUBRICATION

IN the vertical type of internal combustion engine, it is absolutely essential, in order to secure a distribution of the lubricant around the cylinder bore, to supply the oil through a number of feeds, as many as four per cylinder on the smallest sizes and more on larger diameters. A horizontal cylinder, on the other hand, even of the largest size that is practicable to build, can be effectively lubricated over its whole surface from a single feed on the upper side. Gravity helps to distribute the oil.

In any internal-combustion engine, some of the lubricating oil is carbonized. In a vertical engine this carbon tends to work down past the piston, fouling the rings and dropping into the crank pit, where it becomes mixed with the bearing oil. In the horizontal type, much of this carbon is pushed into the counterbore, whence it can be removed through a blow-off valve in the bottom of the cylinder. Such portion as works past the piston can be caught in the frame and prevented from mixing with the bearing lubricating oil. Even the main bearings in a horizontal engine are more effectively lubricated. During the working stroke, when the pressures are highest, the main shaft is partly lifted from the bottom shell, allowing the lubricant to fill the space; again, on the two idle strokes, the exhaust and inlet, inertia effects tend to bring the shaft first against one side of the bearing, then against the other, thus effecting a very thorough distribution of the oil.

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Vol. X JANUARY, 1917 No. 1

PRINCIPAL CONTENTS

Plant and Equipment of Vancouver Ice & Cold Storage Co. 1-4

General 4
Ontario Boiler Rules Revision .... Canadian Power Production.

Power Transmission Section 5-6
Friction Clutches—II.

General 6-7
Canada's 1916 Coal Output....Air Cylinder Explosion ....Boiler Inspection Report, Dept. of Public Works, Province of Ontario.

Electricity and Hydraulics 8-10
Uniflow Steam Engines for Steel Mills.

General 10-11
Piping for Steam Generating Plants....Others' Mistakes and My Own .... Automatic Boiler Feed-Water Regulators....Internal Combustion Engine Lubrication.

Editorial 12
More Effort, More Men, More Money....Passing of a Leading Canadian Manufacturer.

The Operators' Point of View 13-15
Line Shaft Trouble....Steam Trap Trouble....Overcoming Trouble with Steam Pipe....A Fuel Oil Installation....Building versus Borrowing Force Pumps.... Human Factor in the Workshop.

Operators' Instruction Course 16-17
Concerning Indicator Diagrams—IV.

General 17
Canadian Oil Prospects.

Steam Power Plant Auxiliaries 18-19
Steam Traps—VI.

General 19
Rules for Belting.

Progress in New Equipment 20
Pump Valve Reseating Machines .... Mechanical Oil Pump....Compact Friction Clutch .... Water-Sealed Rotary Pumps.

General (Advtg. Section) 56
Britain's Munitions Output.

Selected Market Quotations 63

Projects and Developments 64-65
Trade Gossip....Catalogues....Book Reviews.

MORE EFFORT, MORE MEN, MORE MONEY.

IF there is one thing more than another that the recent peace scare has demonstrated, it is the fact of our being in this war to the "knock out" stage. Beyond the confines of the stock market, where expediency, imagination, or reality, stand ever ready either to woo or create opportunity, little excitement and probably still less business dislocation resulted from the now silenced dual-source peace proposals with their "soft pedal" heralding. Renewed and still more forceful expression has been given of the determination of Britain and her Allies to prosecute the war to its logical conclusion, and in this respect the very untimeliness of the peace suggestions have not been without a salutary effect. As we see it, the Dove of Peace—were that the fair bird or another in its borrowed plumes—has tucked its head under its wing for many months to come, under which circumstances, munitions, men, and money, to the limit of our capacity and resources must needs be our New Year programme. Our Imperial Munitions Board, our National Service Commission, and our Patriotic Fund Executive, all war-created organizations, are more intensely than ever war-in-earnest. Coupled with the "Thrift Campaign" now been planned by our Minister of Finance, Sir Thomas White, it is abundantly evident that our efforts and responsibilities are primarily those of war concern, and, therefore, wasted if otherwise directed and evaded. Much is expected of us during the coming year and largely dependent on our measure of response—ourselves and our substance, will the ushering in of a peace worth-while be hastened.

PASSING OF A LEADING CANADIAN MANUFACTURER

IN the death of Hugh McCulloch, president of the Goldie & McCulloch Co., who passed away at his home, Sorn House, on January 8, Galt has lost one of her leading and most highly esteemed citizens. Mr. McCulloch, who was in his 61st year, was born in Galt on September 7, 1856. He received his education at the Whitby Grammar School and Upper Canada College, on completion of which he served an apprenticeship in the Goldie & McCulloch shops, his father, Hugh McCulloch, sen., being then president of the company. Practically his whole life has been spent in furthering the interests of the firm in which he was a member, and the industrial interests of the community in which he lived. When the company was incorporated in 1891, and took over the business of the firm of Goldie & McCulloch, he was appointed secretary-treasurer, which position he held until elected vice-president in 1898, assuming the presidency on the death of his father in September, 1910. Mr. McCulloch was closely associated with various other manufacturing concerns in Galt, having been at the time of his death vice-president of the Galt Malleable Iron Co., also of the Galt Art Metal Co., a director of the Gore Mutual Fire Insurance Co., also for many years a director of the Galt Gas Light Co. In religion Mr. McCulloch was an honored member of Knox Presbyterian Church. His principal amusements were fishing, golf and motoring. Sorn House, his home, constitutes in itself and location one of Galt's beauty spots. There survive him a sorrowing wife, one brother, R. O. McCulloch, of Galt, and one sister, Mrs. Chas. A. Shearson, of Toronto. The funeral, which took place at Galt on Wednesday, January 10, was very largely attended, the number of local mourners being materially supplemented by friends and business associates from other places.

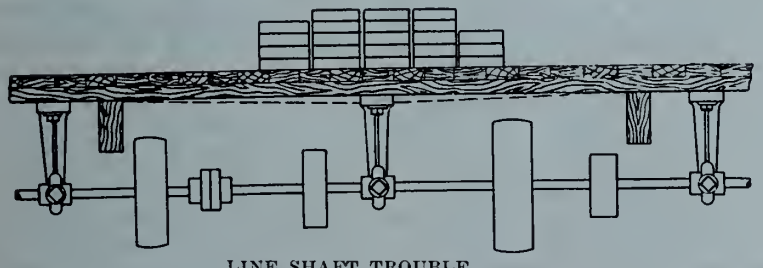
The Operators' Point of View

LINE SHAFT TROUBLE

By J. H. R.

AMONG the many problems that power users are required to solve, those arising from transmission are probably the most numerous. No one application is identical with another, and local conditions make it imperative that each installation, or the solution of trouble arising from unknown causes, must be dealt with on its own merits. Previous experience is often a guide to the difficulties of the moment, but unless a careful study is also made of the local surroundings, it is not to be expected that the results obtained will be entirely satisfactory.

Some time ago, a certain shop was confronted with considerable trouble on a portion of a line shaft, that taxed the patience of the foreman for quite a long period. The accompanying line drawing illustrates roughly the arrangement of the hangers and shafting. As shown, the centre hanger came about midway between two joists, the next on either side being located on the other side of the joists. On numerous occasions the centre bearing would become heated and trouble would develop in the shaft coupling. This experience was not continuous, only taking place at irregular intervals. Several efforts were made to remedy the trouble by lining up the shafting, which on each occasion required adjustment. However, the source was discovered one day when the foreman was on the floor above. He noticed a large pile of cased tin in the centre of the floor and the vibration that developed when another case was added to the pile. Upon investigation, it was found that this lot of tin, weighing over two tons, was placed directly over the hanger



LINE SHAFT TROUBLE

which was giving trouble. Being an old building, this floor was not intended to support any great weight upon a small area. The result in this instance was a depression in the floor, which, being transmitted to the hanger, caused a bend in the shaft and hence originated the trouble. The removal of the cases to a more suitable position and the exercise of care in the subsequent location of all heavy loads effected an immediate permanent cure.

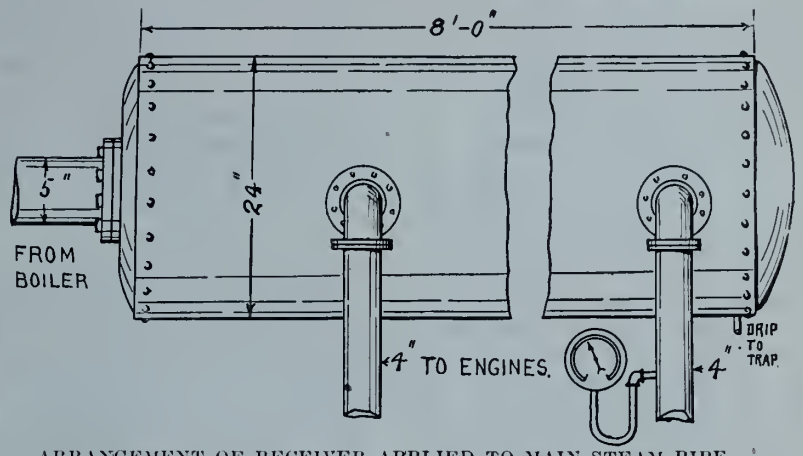
STEAM TRAP TROUBLE

By J. Ford.

IN a large institution known to the writer the exhaust steam from the engines was used for heating water for baths, etc., the water of condensation from the heaters being returned to the hot well by a Bundy steam trap with 1½ in. inlet and outlet. The trap was an old one which had been used for many years previously on a hot water system, having been removed latterly because it did not appear to be working in a satisfactory manner. It appeared O.K. as far as the writer could judge, so it was installed as stated.

When all connections were made and the system started to work, the trap made a few half-hearted efforts and then quit operations altogether. The packing was examined in case of defects, and replaced with new, but the trap continued obdurate. The nuts on the high pressure steam valve were reset without any greater success, and a weighted check valve was also placed on the outlet side on the chance of the trouble being there as it was noticed that the receiving chamber would remain in the lower position, at the same time allowing high pressure steam to blow through continually.

The chamber was thereupon removed and examination disclosed that at some time in the past the 1 in. tube had broken off inside the chamber. A new tube was inserted and the trap connected up again when it started off without further trouble.



ARRANGEMENT OF RECEIVER APPLIED TO MAIN STEAM PIPE.

OVERCOMING TROUBLE WITH STEAM PIPE

by J. James

THE accompanying sketch shows how a case of engine trouble due to defective piping arangement was remedied. A 5 in. main steam pipe supplied steam for two high speed engines direct connected to 300 amp. D.C. generators, the branch steam pipes to the engines being 4 in. dia. When the load was 280 amps. on each generator, the engines would begin to race. The valves were examined and found O.K.; also the governors, and all other parts. A steam gauge was then connected, and when the load reached 280 amps. each, the hand would begin to vibrate considerably.

The conclusion arrived at was that the engines were not getting enough steam.

The 5-in. pipe was disconnected and a receiver installed as shown, which overcame the trouble, all pipes and receiver being well covered to prevent condensation as far as possible.

A FUEL OIL INSTALLATION.

by A. F. Menzies

THE reference to a fuel oil installation in the "Question and Answer" section of your November issue prompts me to give the following description of a mechanical atomisation system installed in connection with a pair of Scotch type marine boilers, and which gave perfect satisfaction. As the job was afloat and in salt water it was considered out of the question to use a steam atomisation system, even though it would have been less expensive to install. The oil was carried in the fore peak tank and a 4 in. suction pipe led from its after bulkhead to the stokehold. On account of the viscosity of the oil, large suction pipes are necessary in order to reduce the velocity and consequently the friction. The oil was pumped by two 3½ in. x 2½ in. x 4 in. steam driven duplex pumps, which, on account of the deleterious action of the oil on rubber, etc., were specified to be fitted with brass rings and valves in the oil end, and to be packed with asbestos. Immediately in front of where the suction pipe entered the pumps, a twin suction strainer was installed, arranged to be cleaned out while steaming.

Steam Supply to Pumps

The steam supply to the pumps was regulated by the oil pressure in the discharge line, the regulating valves being set to the desired pressure, which is usually found by trial. In this particular instance, a pressure of 90 lbs. per sq. in. was found suitable, when using a No. 3 Dahl tip. On leaving the pumps, the oil was piped to a pair of live steam heaters, consisting of a cast iron shell in which a coil of pipe was placed. The oil passed inside the pipe, while steam was admitted to the shell, the temperature of the oil being raised to from 225 to 250 degs. F. A high pressure steam thermometer was installed in the heater outlet in order that the temperature could be ascertained. In a by pass between the pumps and the heater, a Worthington oil meter was installed. To remove any fine particles of grit or pipe scale from the oil, a pair of discharge strainers were installed between the heaters and the furnaces, and as the oil is of much lower viscosity when heated, a strainer of fine mesh can be used on the discharge line.

The header from which the burners were fed was led across the front of the boilers below the furnaces, branches being taken to each burner. The end of the header was connected to the suction pipe in order that a circulation of oil could be obtained on starting up, thus providing heated oil at the burners. The burners themselves, one for each furnace, consisted of a piece of pipe with a special tip at one end having spiral passages leading to a circular hole in the centre.

Fire Regulation

The size of the fire could be regulated by varying the pressure of the oil. If the desired results could not be obtained within the suitable range of pressures, it was a very simple matter to subsitute a tip with a larger or smaller hole as the case required. With the beforementioned pressure, a tip with a 1-32 in. hole gave very good results. The furnaces were 37 inches in diameter. The outer end of the burner had a special union connection to the oil pipe branch, and could be removed by the slackening of one set screw. If a burner did not work satisfactorily or got choked up, it was the work of less than half a minute to remove it and substitute a spare one. Surrounding the burner tip was a hollow cast iron cone with the apex pointing to the furnace front. The cone was carried on a pipe through which the burner passed and was made conveniently adjustable, in and out. Its correct adjustment was an important factor in smokeless combustion.

The fire bars, bearers and all brick work, were removed from the furnace and new fronts were installed. The fronts were ⅜ in. plate and had hinged air doors above and below the burners. Commencing at the front, the furnace was lined with firebrick for about three feet, in order to give protection from the intense heat. A considerable reduction in the consumption of fuel was obtained by the use of spiral retarders in the tubes. It will be noted in this installation that all important items, pumps, strainers and heaters, were installed in duplicate, the object to avoid a shut down. If this precaution were not considered necessary, a single pump and heater could be used. Strainers should, however, be duplicated. The apparatus for this installation was secured to the stokehold bulkhead, and was so connected up with unions that any piece could be undone and removed for convenient overhaul.

Oil Burning Regulations

Some of the more important regulations which have to be observed in connection with an oil burning system coming under the control of the Canadian Steamboat Inspection are as follows: Storage tanks must be absolutely tight and constructed of not less than ¼ in. plate. The stop valve on the tank end of the suction pipe must be located inside the tank, and the spindle extended through a stuffing-box on the tank top. The idea of this is to prevent leakage from the valve spindle draining into the bilges. Proper ventilation must be provided for the tank. The exhaust steam from the oil heater must not be piped to the condenser; but must be drained overboard or into the bilges.

In any oil installation, ground joint union and regrinding valves are an absolute necessity. After installation and before oil is admitted to the pipes they should have all dirt, pipe scale, etc., blown out with compressed air or steam. It is a comparatively easy matter to clean the pipes when first put up, but it is a different story after they have been filled with sticky oil.

The Economy Feature

As regards the economy of using liquid instead of solid fuel, this simply resolves itself into a question of their relative costs. On the Pacific Coast, where coal contains between 12,000 and 13,000 B.t.u. per lb., and the grade of oil sold for fuel purposes runs from 19,000 to 20,000 B.t.u. a ton of coal is usually regarded as equivalent to from 3½ to 4 barrels of oil. Oil can be wastefully fired just as easily as coal, if not, more so, as there is less labour involved for the fireman if he is economical with his coal. There is the saving of labour handling to be figured to the advantage of liquid fuel. In this particular installation no exact comparison was possible.

All the special apparatus used on this installation was manufactured by the Union Iron Works, of San Francisco, Cal., under the Dahl patents. The work of installation was carried out by the Wallace Ship Yards Ltd. of North Vancouver, B.C. Lunkenheimer regrinding valves, and Dart unions were used throughout.

BUILDING VERSUS BORROWING FORCE-PUMPS

By J. E. McCormack.

THE coming into force of clause 5, sec. 57 of the revised Provincial (Ont.) laws relating to boiler inspection has resulted in an epidemic of force-pump borrowing in many localities, which can scarcely be profitable in many instances where express charges have to be paid both ways, especially when one considers how readily a pump can be constructed out of steam pipe and fittings.

The significance of the force pump question is more fully realized when reference is made to the itemized record of inspections as given in the last annual report of the Factory Inspection Branch for the Province of Ontario, in which the number of localities in which there was only one inspection was 25 per cent., and those with only 2, 3 or 4 inspections about another 25 per cent. Additional force being lent to this statement when it is remembered that many of the plants in towns and cities have insured boilers, or operate on electricity or gas, while the isolated plants are invariably steam-driven.

Force-pump Construction

As a result of the writer's desire to possess his own force pump and avoid the annual borrowing, a home-made affair was constructed which in spite of simplicity and low cost performed the work satisfactorily. Investigation of a certain scrap heap resulted in the discovery of two old style check valves, which had been replaced by renewable face valves. These were re-ground, rendering them serviceable for a time and were connected together by two 1-in. nipples and a tee. A plunger was made by using a piece of ½-in. pipe, 28 in. long, while the cylinder was made of 1-in. pipe, 24 in. long, with a 1¼-in. x 1-in. bushing, and a 1¼-in. cap on one

end, the cap being drilled with a 7/8-in. hole. The 1/2-in. pipe was now passed through the 1¼-in. cap, and a 1/2-in. cap placed on the inner end, the burr on the ends of the 1-in. pipe being previously removed to clear the 1/2-in. cap. A tee was now put on the outer end of the 1/2-in. pipe, capped nipples of suitable length being inserted in each side of the tee to form handles, after which the 1-in. pipe was screwed home in the tee between the two check valves. See Fig. 1.

Packing the Plunger

The 1¼-in. cap was removed and some candle wick wound in the space between the bushing and the plunger, while good piston rod packing was placed inside the 1¼-in. cap, which was then replaced. Boiler connections were now required to complete the apparatus, and for this purpose a union or pair of pipe flanges is most convenient.

The actual material used was according to the following list:—1 piece 1/2-in. pipe 28 in. long, to be carefully handled in the vise to avoid damage while threading; 1 piece 1-in. pipe 24 in. long; 2 1-in. nipples; 2, 1/2-in. nipples; 2 check-valves; 1, 1-in. tee; 1, 1/2-in. tee; 3, 1/2-in. caps, 1 will do; 1, 1¼-in. cap; 1, 1¼ x 1-in. bushing; some candlewick and piston rod packing. If purchasing new check valves, the writer would have the suction check the same size as the plunger, with the delivery check a size smaller; this would call for a change of the nipples as listed above, with an extra bushing also. By having the plunger 4 in. longer than the cylinder, the chances of jamming one's fingers while working are removed.

Pressure Capacity

With a plunger 1/2 in. dia., and little or no leakage, one man could put on a

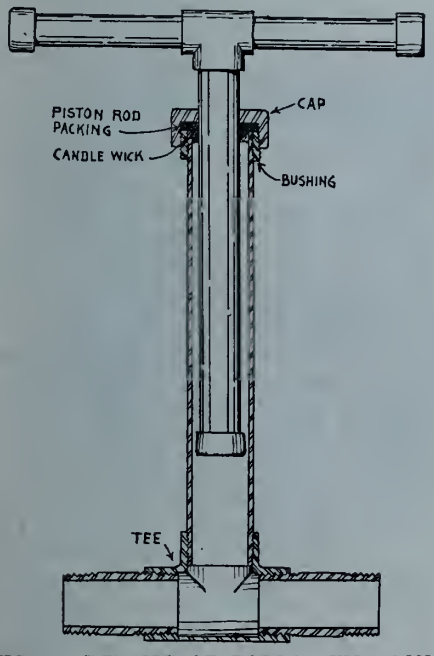


FIG. 1. DETAILS OF FORCE PUMP CONSTRUCTION.

pressure of 130 to 140 lbs. per sq. in. and with a 3/8 in. dia. plunger, 160 lbs. per sq. in. could be obtained; where there was considerable leakage, however, as through a worn safety valve or throttle, the amount of water handled was too limited. To meet such a case, should it arise, there was provided as extra equipment a piece of 1¼-in. pipe, 25 in. long, for the cylinder; 1 piece 3/4-in pipe 30 in. long for plunger, with 3/4-in. cap on one end and a tee on the other; 1, 1½ x 1¼-in. bushing with 1½-in. cap (drilled) for stuffing-box; and 1, 1¼-in.

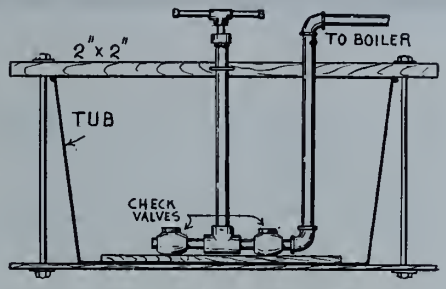


FIG. 2. ARRANGEMENT OF FORCE PUMP FOR TESTING BOILERS.

tee and 2, 1¼ x 1 in. bushings for connecting the 1¼-in. cylinder to the same old check valves. This gave a certain amount of adaptability to circumstances and by using a piece of broom handle in the plunger tee, two men could take hold to operate. It was not found necessary to finish the plunger any more carefully than by filing off the most prominent rough spots, the fill being mostly used lengthwise of the pipe.

Arrangements for Use

The success attending the use of apparatus of this class is largely due to the fact that—unlike a steam cylinder—a water cylinder does not necessarily require a snugly fitting piston, so long as the water flows to the inlet, and there is no leakage at the valves or stuffing box. In using the outfit, a tub was secured and a piece of board fitted inside to protect the bottom and another piece across the outside, after which a 2 in. square piece was placed across the top and tied down to the bottom board with rods. The pump was now placed on the inside board and the upper end of cylinder secured to the cross-piece with a U-bolt. A street elbow in the high pressure check and a piece of pipe with another elbow allowed boiler connections to be made above water level; and by filling the tub with water, the pump held firmly with a water supply free from air leaks during the suction stroke except what little might get in through the stuffing-box, which, however, was almost watertight during the pressure stroke.

Other People's Efforts

The above efforts have been so successful, that instead of borrowing, the writer is now lending his pump to others and so far no complaints have been heard regarding its work. As offering a comparison with the foregoing apparatus, the writer remembers one party who had a boiler-feed pump which was so designed that it could be partially dismantled and then operated by means of a hand lever; it was used when required for boiler testing purposes when it was operated by four men at the ends of a 2 x 4 in. scantling. After trying in vain to get up sufficient pressure for testing purposes, he borrowed one of the pumps described herein. Another man claims that he can, and is going to make a force pump that he can take apart and carry in his grip, giving as his reason the fact that he does considerable work among outfits which work intermittently and that he is frequently obliged to inspect the boiler before commencing operations. He has a wide acquaintance and claims to be able to keep in work most of the time by keeping in touch with the various employers on his "route," few of whom own suitable force pumps.

HUMAN FACTOR IN THE WORK-SHOP

By J. Wright.

PRESENT-DAY competition has become so keen that the scientific and mechanical world are working at high pressure devising ways and means to increase the quality and quantity of manufacturing output at a minimum expenditure, both of money and material. It is only within the past few years, however, that any great amount of consideration has been given the general betterment of conditions under which employees operate in industrial establishments. It is encouraging, however, to note that the value of the human element is being more and more appreciated at its true value.

Examples might be cited where material gain was falsely considered of more importance than the health or welfare of the employee. Some years ago on a certain machine, the "boss" had considerable difficulty in keeping it in continual operation owing to the irregular attendance of the operator, who was absent quite often as a result of contracting heavy colds, due to the draught created by the opening of a nearby door. A screen was suggested, but nothing was done until the season arrived when artificial light was necessary. The open gas jet could not protest against the draught, but, as the light was essential, a screen was erected to "protect the light," and thus provide a better opportunity for the man to work.

On another occasion the superintendent was showing a visitor about the works, and happened through the galvanizing department at a time when some tanks were being supplied with fresh acid. The visitor lost no time in seeking the freer atmosphere of the adjoining room, remarking to his host that he would not work in such a place for $20 a day. The boss replied that "the men did not mind it; in fact, they actually eat the stuff." This was probably true, and they were doing it for much less than $20 a day, or even a week, while in reality the fumes from the acid were slowly consuming them as the days rolled by. However, not long after this visit facilities were provided to aid in carrying off the poisonous fumes and permitting healthier working conditions for the employees.

Operators' Instruction Course

CONCERNING INDICATOR DIAGRAMS—IV.

IN our December issue, the features of the steam expansion curve, cylinder clearance, characteristic cards from a variety type engine, also the occurrence and causes of faulty diagrams,

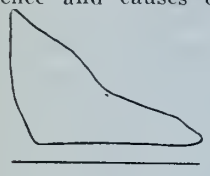


FIG. 14.

FIG. 15.

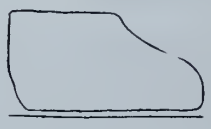


FIG. 16.

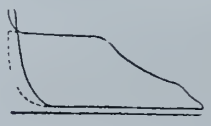


FIG. 17.

were dealt with at some length. A further discussion of the latter constitutes the introductory section of the present article, followed by an extended reference to the procedure followed in indicating compound engines, and combining the resultant diagrams.

Faulty Diagrams

Steam Throttled During Admission, Fig. 14.—When steam is throttled during admission, the steam line drops instead of being horizontal, indicating that the steam port is not open for a sufficient time.

Cut-off Too Early, Fig. 15.—The steam expands until its pressure is less than the back pressure, and the expansion line crosses the back pressure line to form the loop (g). This is frequently found on automatic cut-off engines working on light load. On such engines it is caused by too high steam pressure and wastes steam for the amount of work done, besides causing reversal of pressure and pounding. It cannot be remedied by re-setting the valve. Steam must be throttled, the back pressure lowered by running condensing, or the engine run slower. The dotted line shows the result of slowing down the engine and cutting off later. This diagram shows also the result of too early compression. The steam is compressed in the clearance

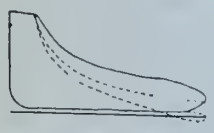


FIG. 18.

FIG. 19.

space until the pressure rises above that in the steam chest.

Cut-off Too Late, Fig. 16.—This is characterized by a high pressure at release, and means a big waste of steam due to its inability to do more work by expansion before the exhaust opens. The boiler pressure should be raised so that a diagram of equal area may be obtained with an earlier cut-off, or the revolutions of the engine increased, and the cut-off made earlier.

Compression Too Early, Fig. 17.—When compression takes place too early the pressure in cylinder rises above that in the steam chest, and may cause chattering of the valve, pounding and heating, in addition to reducing the effective work of the steam. The dotted area plus the loop indicate the additional work obtained by setting the valves for proper compression. A similar loop may be caused by the absence of load on the steam valve, but when this fault occurs the loop comes to a sharp point at the top.

Leaks Indicated by the Expansion Line, Fig. 18.—If the expansion line is noticeably above the theoretical adiabatic expansion line, steam enters the cylinder through a leaky valve after cut-off. If the expansion line falls below the theoretical, steam leaks past the piston, or gets out through a leaky exhaust valve.

Leaks Indicated by Compression Line, Figs. 19 and 20.—The curvature of the compression line changes as the piston nears the end of the stroke, sometimes even forming a hook. This indicates the escape of steam from the compression space, either through the exhaust or past the piston.

Condensation and Re-evaporation in Cylinder, Fig. 21.—If the expansion

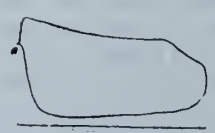


FIG. 20.

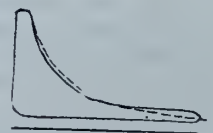


FIG. 21.

curve falls below the theoretical adiabatic line at the beginning of the stroke, crosses and then goes above, it is a fair sign that excessive condensation occurs at the beginning of the stroke, and re-evaporation during the latter part. Superheated steam will remedy such trouble and restore the expansion line to the normal position.

Very Bad Diagrams, Fig. 22.—There is here shown the worst imaginable distribution and waste of steam. The admission is late, there is almost no cut-off, and the steam port is opened so gradually that full steam pressure is not attained until the end of the stroke. The exhaust opens slowly and atmospheric pressure is not attained until two-thirds of the back stroke has been completed. Fig. 23 shows a similar exhaust line, due in the particular case to excessive back pressure from the feed water heater.

Indicating Compound Engines

Indicator diagrams of compound engines are taken in the same manner as on simple engines. Three cards are shown, Fig. 24, taken from a triple expansion cross-compound Corliss engine. The cards for the different cylinders are taken with different scale springs in or-

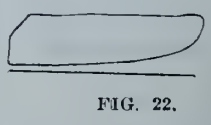


FIG. 22.

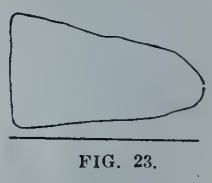


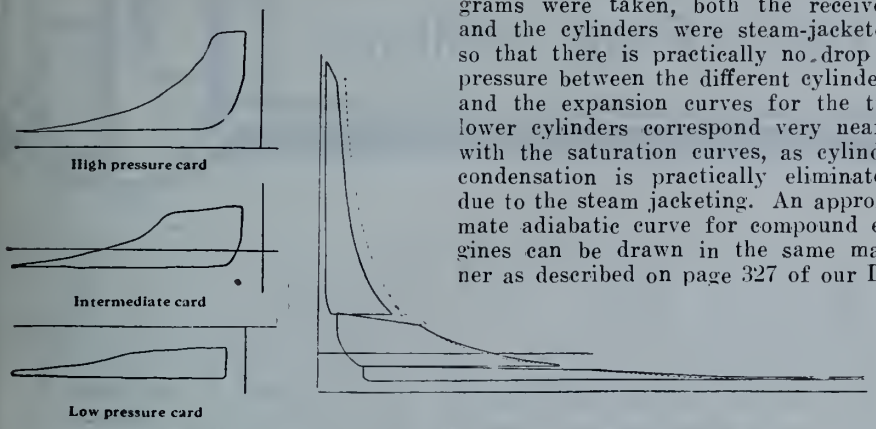
FIG. 23.

der that their areas may be large enough to show up well. From these cards it is seen that the high pressure cylinder is working entirely above atmospheric pressure. In the intermediate cylinder the pressures run both above and below while the low pressure cylinder works entirely below atmospheric pressure.

In order that these cards may appear in a proper relation, one to the other, they are usually combined on one large diagram. To do this, the pressures and volumes in the several cylinders have to be reduced to a common scale, and when so laid out the different cards fall in their relative positions, as seen in Fig. 25. In the combined card, the total length of each individually represents the volume of the corresponding cylinder in cubic feet. The cards shown on the combined diagram for each cylinder represent the average of several cards for both sides of the piston. In laying out the cards, the distance from the line of no volume represents the mean clearance volume for each side of the piston for each cylinder.

Combined Cards of Triple Expansion Engine

In order to get some idea of the distribution of the steam in the various cylinders, it is generally customary to draw on the combined card, saturation and adiabatic curves. One saturation curve cannot be drawn for three cylinders as the weight of the steam expanding in each is different, due to the different clearance volumes. The saturation curves are constructed by taking the values of the pressure and volume from Steam Tables of the weight of steam expanding in each cylinder. The weight of the steam in each case is the steam used by the engine per stroke, plus the weight of the steam entrapped in the clearance space. The steam used per stroke can only be accurately determined by tests. The weight of steam in the clearance is obtained by knowing the clearance volume in cubic feet and the pressure at the end of compression taken from the indicator card, from which the weight can be obtained from Steam Tables by finding the weight of a cubic foot at the given pressure; from this, in turn, the weight in the clearance volume is easily calculated. This should be done for each cylinder, and saturation curves drawn as indicated.



FIGS. 24 AND 25. INDIVIDUAL CYLINDER AND COMBINED DIAGRAMS OF TRIPLE EXPANSION ENGINE.

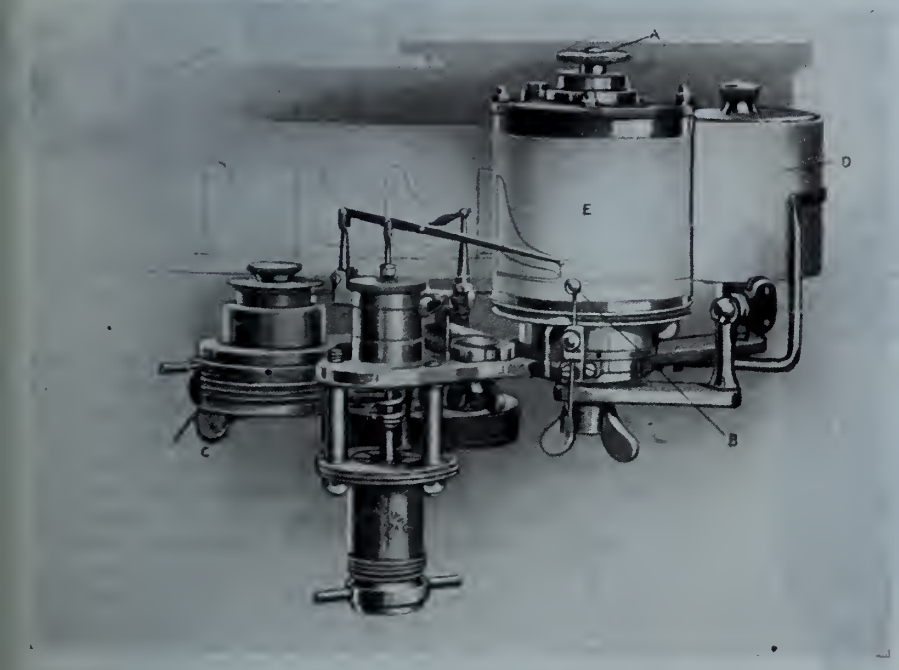
In the engine from which these diagrams were taken, both the receivers and the cylinders were steam-jacketed, so that there is practically no drop in pressure between the different cylinders, and the expansion curves for the two lower cylinders correspond very nearly with the saturation curves, as cylinder condensation is practically eliminated, due to the steam jacketing. An approximate adiabatic curve for compound engines can be drawn in the same manner as described on page 327 of our December issue. This will come slightly above the saturation curve.

By taking indicator cards from compound engines, following points can be determined. First, it can be ascertained if the lead is evenly distributed between different cylinders. Second, the adjustment of the valves can be effected the same as in a simple engine. Third, by the difference in pressure between the exhaust of one cylinder and the admission of the next one, it can be known if the receivers and piping are of proper proportions. An excessive drop between cylinders may indicate excessive condensation or that the piping is too small.

Compounding Advantages

One of the advantages incident to componuding steam engines is the equalization of the turning effort on the shaft. Thus, in a triple expansion engine having three cylinders, the three cranks are usually set at 120 degs. apart, and if an absolutely uniform turning moment is desired, it is necessary that the thrust given on each of these pins be equal. Most steam engines are so designed that this effect will be secured; however, frequently due to the valves not being properly set, it is found that one cylinder is doing much more work than the others and that the benefits due to using more than one cylinder are lost. Therefore one of the points to be ascertained in indicating compound engines is if the net work done in the different cylinders is equal. This can be approximated by theoretical methods if the initial pressure and dimensions of the cylinder are known, but it is much better to find it practically by means of an indicator. If the indicated horse-power from the separate cylinders of a compound engine are not equal, the valves should be adjusted until this is secured.

Equal work in the different cylinders is especially necessary when compound engines are direct connected to alternators which run in parallel. Here differences in angular velocity due to unbalanced work in the different cylinders will cause momentary changes in the voltage of the different generators and cause hunting. This spoils the regulation of the machines and cuts down their capacity.



"TRILL" TYPE CONTINUOUS INDICATOR WHICH GIVES AN INDICATOR CARD PER ENGINE STROKE.

CANADIAN OIL PROSPECTS.

OIL possibilities in Canada are discussed in a statement just issued by the St. John, N.B., Board of Trade, which says:—

"New Brunswick possesses a valuable asset in its oil shales deposits. One of the best English authorities on oil, Sir Boverton Redwood, who made an exhaustive survey of this deposit two years ago, reported that the New Brunswick shale was capable of producing thirty-three Imperial gallons of crude oil per ton of shale, and sixty pounds of sulphate of ammonia. It is estimated that a plant with a capacity of 1,500 long tons per day can retort 547,500 tons per annum, equaling 18,000,000 Imperial gallons of crude oil and 13,687 tons of sulphate of ammonia. The oil may be divided as follows: Gasoline, 2,137,500 gallons; illuminating oil, 7.951.500 gallons; lubricating oil, 2,565,000 gallons, fuel oil, 1.710.000 gallons; paraffine wax, 6,120,000 pounds; coke, 1,530 tons.

This distillation estimate is based upon the old method. By some of the newer methods it is claimed that the New Brunswick shale oil will produce more than three times the above quantity of gasoline per ton. It is believed that there is already sufficient shale available to operate for fifty years at least five plants of the capacity of the one above proposed. The New Brunswick shale is said to be of much better quality than the shale of Colorado, and the quantity is greater. The geological authorities at Washington, recognizing this fact, have been devoting considerable attention to the New Brunswick deposit. Increased development in connection with these deposits is looked for within the next few months."

Steam Power Plant Auxiliaries

STEAM TRAPS—VI.

TWO designs of steam traps are built and marketed by Sheldon's, Ltd., Galt, Ont., these being intended to meet the varied requirements of all classes of steam users. The traps referred to are known as Intermittent Flow, and Universal.

The intermittent flow traps are illustrated in Fig. 34, which shows the interior and exterior of the device. The water enters through the inlet port on the right, the baffle being so shaped as to prevent the water from entering the bucket except by overflowing in the proper way. The loss of buoyancy when filled allows the weight of the bucket to withdraw the valve from the seat, the pressure of steam in the trap causing the water to be discharged upward through the vertical guide tube. A by-pass valve in the cover allows water and air to pass through freely without the trap acting.

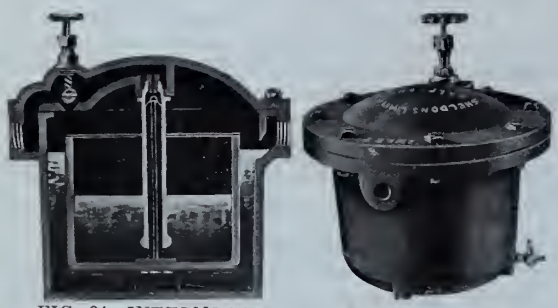


FIG. 34—INTERMITTENT FLOW STEAM TRAP.

These traps are made for either high or low pressure, in five sizes, from ¾ in. to 1½ in., having capacities of 1,800 to 15,000 lineal feet of 1-in. pipe.

The universal steam trap will work on any steam pressure up to 150 lbs. per sq. in., the same trap being applicable to exhaust or low pressure steam as to high pressure work. The sectional view, Fig. 35, shows the principle of construction On first entering the trap, the water fills the open bucket or float, overcoming the weight of the counterpoise and pulling the valve up to a closed position. The continued inflow of the water fills the body of the trap, rising around the outside of the float and gradually increasing its buoyancy until the downward pressure of the counterpoise is sufficient to open the valve. The trap now discharges and lowers the level until reduced buoyancy of the water-filled float causes the valve to close again. When operating under high pressure the water only rises a few inches up the float, but on very low pressure it rises to within an inch of the top of the float before the valve is opened.

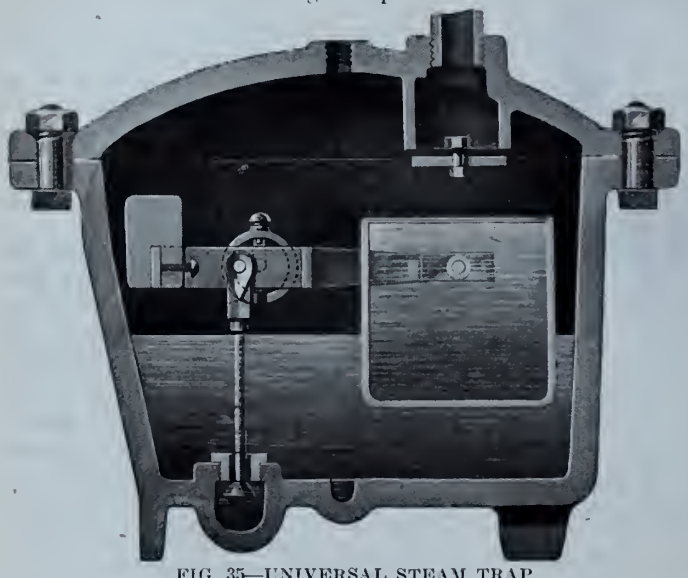


FIG. 35—UNIVERSAL STEAM TRAP.

Pratt Return Steam Trap

This device belongs to that class of apparatus which automatically returns water of condensation into the boiler at the highest attainable temperature. The principal features of construction are shown in Fig. 36, the receiving vessel being of spherical shape, inside of which is a float O suspended from lever P, which in turn is operated from the outside by lever B carrying a counterpoise. Attached to lever B is a rocking arm C, carrying a rolling weight M, which rolls to either end alternately as the feeder fills and is emptied of water, the action of the roller taking place simultaneously with the opening and closing of steam valve D. Condensation is received through inlet G and discharged through F, live steam from H being admitted as required by the action of valve D. This apparatus is manufactured by the Pratt & Cady Co., Hartford, Conn.

Cranetilt Direct Return Trap

This is one of a series of tilting traps built by the Crane Co., Chicago, which includes also non-return traps and three-valve traps, the latter being adapted for service as lifting traps, vacuum traps, and metering traps. This return trap is shown in Fig. 37, and will work on pressure up to 250 lbs. per sq. in. The number of operating parts has been kept at a minimum, there being no interior valves, buckets, levers, or other working parts. The steam and vent valves are on the outside, while the trunnions have the full area of the pipe connections.

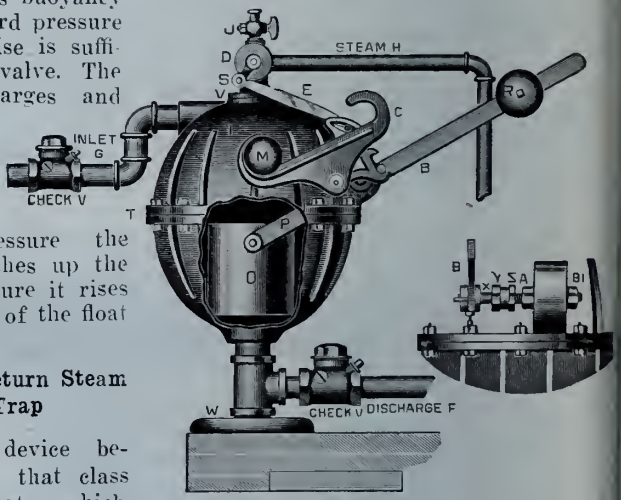


FIG. 36—PRATT & CADY RETURN STEAM TRAP WITH TILTING LEVER.

Condensation enters the trap through the inlet check valve and passes through the divided trunnion tee into the tank. As the tank fills, the weight of water causes it to drop to the bottom of the yoke, and in doing so, the steam valve is opened and the vent valve closed. The pressure now enters through the steam valve and the inner pipe into the space above the water, closing the inlet check

valve and equalizing the pressure in the trap with that in the boiler, so that the water flows into the boiler by gravity from the trap, which should be located not less than four feet above the water-line of the boiler when used for this work.

After sufficient water has left the tank, the counterweight brings it back into the filling position. This action closes the steam valve and opens the vent valve, allowing the pressure in the tank to equal or fall below that in the return lines, after which the operation is repeated.

Morehead Boiler Feed.

This apparatus is illustrated in Fig. 38, the type of trap shown being known as the Morehead Tilting Return Steam Trap and Boiler Feed. This device is constructed with a horizontal tilting steel tank, supported by a vertical pipe and a sloping pipe, which are connected with the trunnion passages. Water enters and leaves the tank by the sloping pipe, the inlet and discharge being through the passage on one side of the trunnion.

FIG. 37. CRANETILT DIRECT RETURN TRAP, SHOWING PATHS OF STEAM AND WATER.

FIG. 38. SECTIONAL VIEW OF MOREHEAD TILTING RETURN TRAP.

while the steam enters the tank through the vertical pipe, the upper end being well above the water-line.

Bolted gland boxes on the trunnions are a feature of the design which avoids trouble, due to stuffing nuts tightening up or loosening with the oscillation of the trunnion bearings. Renewable disc valves are employed, the large valve bonnets being easily removed with an ordinary wrench, and the valve stems fitted with gland packing boxes.

The Canadian Morehead Mfg. Co., Woodstock, Ont., build three additional types of the above apparatus, which meet all conditions arising in steam and gas plants, i.e., condenser traps, non-return or tank traps, and vacuum traps, a feature of the condenser trap being the introduction of a water spray which forms a positive vacuum in the tank, thus removing the condensation rapidly from the system and accelerating the travel of the steam. The vacuum trap operates on systems under a vacuum without breaking the vacuum, and delivers the condensation to any desired point above or below the trap, these various results being obtained through apparatus of similar general construction to the return trap described with such minor variations as are necessary to enable them to perform their duties.

RULES FOR BELTING

IT is difficult and costly to correct a faulty belt drive once it is installed, hence every care should be taken to design it efficiently in the first place. The following formula for belt width has been recommended by C. J. Morrison in an article contributed to the "Engineering Magazine":—

$$\text{Width (ft.)} = \frac{(F \times HP \times 180)}{(S. \times \text{Arc of Contact})}$$

where F = sq. ft. of belt passing over pulleys per minute per horse power transmitted; HP. = horse power; S = belt speed in ft. per minute. The arc of contact is measured on that pulley which has the smaller arc of contact. Experience extending over a period of years and covering thousands of belts shows that suitable values for the factors F and S are 160 sq. ft. and 3,000 ft. per min. for single belts, and 80 sq. ft. and 3,000 ft. per min. for double belts. These factors yield a belt which is somewhat expensive in first cost, but one which is economical in the long run owing to its durability, freedom from breakdown and ability to transmit the required power.

Good single belts are not easy to obtain in widths exceeding 12 inches, but double belts should not be used on pulleys less than 6 in. in diameter, nor triple belts designed on pulleys less than 20 in. in diameter. Belts designed by the above formula and running on cast iron pulleys should have an initial tension of 71 lbs. per inch of width for double belts, 35 lbs. for single, and 106 lbs. for triple belts. Generally it is not easy to measure the tension, in which case it may be provided by deducting 1 in. per 10 ft., as measured over the pulleys using a steel tape. With other than cast iron pulleys, lower belt tension or (preferably) a narrower belt and the same tension may be employed. When using other pulley materials, the belt width as found by the above formula should be multiplied by the following reduction factors:—For leather faced cast iron pulleys, multiply by 0.89; cast iron with projecting corks, multiply by 0.85 to 0.87; wooden pulleys 0.86, ditto with projecting corks 0.88; paper pulleys 0.80, ditto with projecting corks 0.02 to 0.83.

For general machine shop practice, 15 ft. is a good distance between pulley centres, but heavy drives may be on 20 ft. centres; if one pulley is 6 ft. or over in diameter, the pulley faces may be set 25 ft. apart. Open belts should be run with the tight side below; crossed belts with the tight side on top. No belt wider than 8 in. should be crossed if any other method of driving is available. Quarter turn, half turn and other "mongrel" drives are to be avoided. Too much care cannot be bestowed on aligning pulleys accurately, and whenever possible idlers or slide rails should be provided to take up belt slack and permit the use of endless belts. Idlers should always be on the slack side of the belt and as near as possible to the smaller pulley.

Progress in New Equipment

PUMP VALVE RESEATING MACHINES

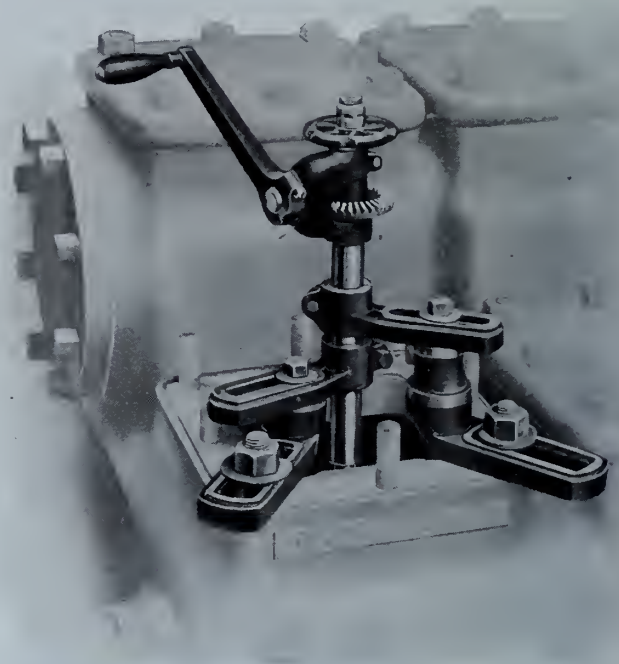
ONE of the chief factors in the maintenance of high efficiency pump operation is that of the care given the upkeep of the various valves forming part of each pump unit. The effect of wire drawing and the presence of grit in the water soon result in poor fitting valves; it is, therefore, essential that the occuracy of the latter and their seats be maintained. Where the failure of a pump to effectively perform its allotted task means the temporary shutdown of a portion of a plant, the question of prompt repairs is a very important feature.

The accompanying cuts illustrate several applications of the Dexter pump valve reseating machines, and feature their usefulness in the repairing of various types of pumps now in service.

Simplicity of construction of this apparatus is coupled with high efficiency of action; a feature of their operation being the ease with which they are attached to any valve chamber. For the smaller sizes of valves, the single yoke device is used, but for the facing of the larger valves a double yoke is provided. The latter offers additional support for the bearing sleeve, through which the tool spindle operates. This improvement is a highly desirable feature where the valve seats are somewhat below the surface in the valve chamber, as the double clamping facilities offer increased rigidity when the machine is in service. For the smaller sizes, the cutter is driven direct by a handle attached to the spindle, and is operated in a direction parallel to the face of the cutter. In the large sizes, where more power is required, the cutter spindle is revolved by means of beveled gears working in a bracket secured to the upper end of the bearing sleeve; in this case the power handle operates at right angles to the cutter face.

Where the arrangement of the valves does not permit of using the long bearing sleeve, special devices are provided for the facing of the seats, the pressure being obtained by means of adjusting screws operating in the clamp, or against the opposite surface of the valve chamber; the cutter being revolved by means of a ratchet handle, which permits of successful application in the most confined locations. The type of cutters used on these attachments are made of best quality steel, and are otherwise designed to meet their special work. The action

DEXTER PUMP VALVE OUTFIT DH6.



DEXTER DOUBLE YOKE PUMP VALVE RESEATING MACHINE REFACING SUCTION VALVE SEAT.

DEXTER PUMP VALVE ATTACHMENT RATCHET OUTFIT R.

CYLINDER OIL—

Necessary for lubrication, but injurious when that function has been performed

Cylinder oil is necessarily used in engine and pump cylinders, but its usefulness ends with the process of lubrication, and unless it is completely removed from the exhaust steam, serious trouble will develop in condensers or boilers.

To remove oil from exhaust steam, there must be interposed in the path of the steam a series of baffles, which will collect the particles of oil and conduct them away from the current of flow.

Elliott Oil Separators

both collect the particles of oil and conduct them out of the path of the steam.

The baffles of the Elliott Oil Separators, Type "P," consist of a double row of V-shaped plates. The first row merely directs the steam at the proper angle against the second row of baffles, which in turn throws the particles of oil back into the recess angles of the first row, so that the oil is completely out of the path of the steam.

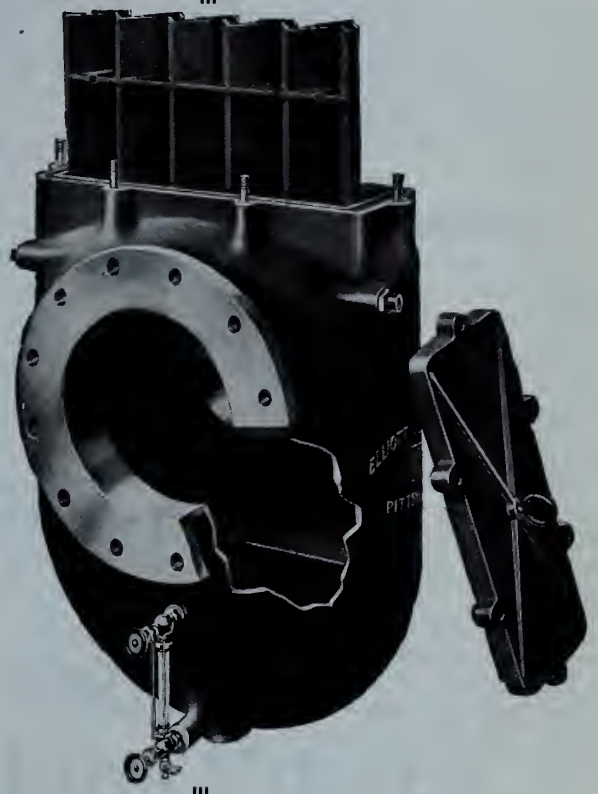
The baffle plates are kept moistened with jets of water from a spray pipe (see spray pipe connection at side of accompanying cut). With the baffle plates in a moist condition, the particles of oil readily form into globules or large drops, and run down into the reservoir.

If a water spray is not used in an oil separator, the particles of oil cling to and eventually gum the baffle plate to such an extent that the steam is enabled to pick up the oil from the surface of the baffle plate and carry it on into apparatus farther down the line.

Further, the baffles of Elliott Oil Separators are removable—they can be taken out of the Separator and cleaned with hot water, gasoline or soda. There is no reason for not keeping the baffle plates in as clean a condition as when the Separator is new.

Removable baffle plates is a feature found only in Elliott Oil Separators.

Bulletin "E" contains a complete description of Elliott Oil Separators, and will be sent on request.



Type "P" Oil Separator showing how baffles may be removed for cleaning.

ELLIOTT COMPANY

6902 Susquehanna Street, Philadelphia, Penna.

OTHER PRODUCTS:

Steam Traps	Combination Separators
Feed Water Regulators	Oil Reclaimers
Feed Water Heaters	Twin Strainers
Reducing Valves	Twin Filters
Faber Blow-Off Valves	Twin Grease Extractors
Steam Separators	Intake Strainers

of the cutter leaves the surface of the seat perfectly smooth and free from chatter marks. Other designs of Dexter re-

DEXTER IMPROVED TYPE PUMP VALVE CUTTER.

seating tools meet the repair needs of valves on the high pressure hydraulic pumps installed in connection with shell forging plants.

Darling Bros., Montreal, manufacture the foregoing products for Canadian distribution.

MECHANICAL OIL PUMP

THE oil pump shown in the accompanying engraving has been specially designed by the makers for lubricating the cylinders of Diesel oil engines, air compressors and stationary and portable steam engines. The mechanism is so arranged that all moving parts are located inside and are either immersed in oil or automatically lubricated, this feature, coupled with the use of suitable materials for the various parts imparting great durability to the apparatus; the body lid and driving wheel are of close-grained cast iron, while hardened tool steel is employed for the wearing parts, such as ratchet wheel, pawls and eccentrics, with bronze for other parts.

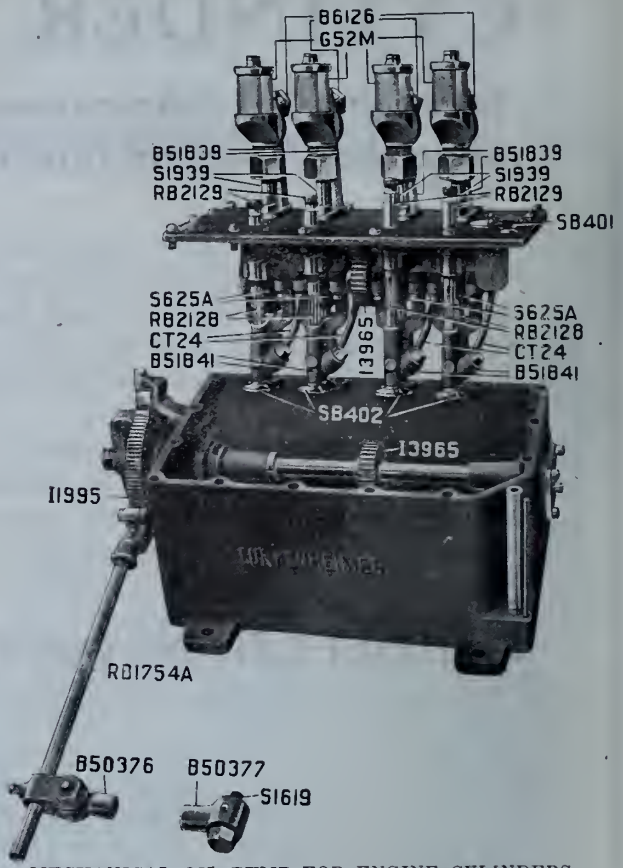
The majority of parts are attached to the lid and are removed with it, facilitating inspection and repairs. The operating ratchet lever is connected to any part operating only when the engine is running. The filling hole is quite large for convenience in filling; a sliding cap to prevent dirt from entering is provided with a removable bronze strainer inside. Each outlet is vided with independent feed regulation and sight feed, the feed being readily adjustable without the use of tools.

The Lunkenheimer Co., Cincinnati, are the makers of this oil pump, which is built with one to four feeds, having capacities from one quart to one gallon.

COMPACT FRICTION CLUTCH

THE friction clutch shown in the accompanying illustration is specially adapted for use as a part of any machine on account of its small size, and when modified to meet the requirements of individual machine tool builders is equally as satisfactory as the standard types. The Johnson clutch, as will be observed from illustration, consists of a body fastened to the shaft, carrying a split ring, in which are inserted a pair of levers. A curve-shaped wedge, which is made a part of the shipper sleeve, forces the levers apart, expanding the ring and bringing its outer surface into frictional contact with the inner surface of the friction cup, the hub of which is made to suit requirements.

The leverage is so compounded that



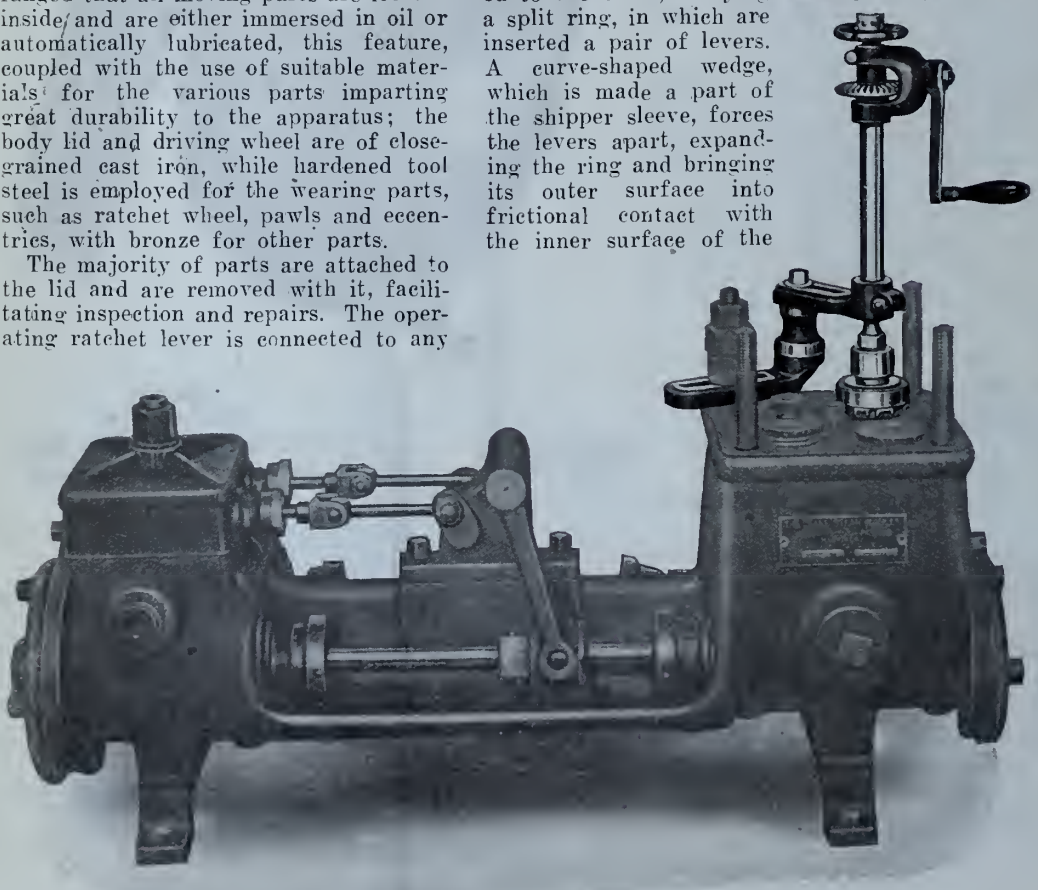
MECHANICAL OIL PUMP FOR ENGINE CYLINDERS.

very slight pressure is sufficient to operate the clutch. One screw which moves two taper blocks set into the levers adjusts the contact of the ring and cup to any required degree, the screw being easily reached with a screwdriver through a hole in the friction cup. The smooth shipper sleeve entirely covers the working parts, protecting them from dirt, etc.

These clutches are manufactured by the Carlyle Johnson

SINGLE FRICTION CLUTCH WITH PULLEY.

Machine Co., Manchester, Conn., and have been extensively adopted on various types of automatic machines, besides being well suited for line and countershaft service. A double clutch is also made which occupies very little more space than the single type illustrated,



DEXTER SINGLE YOKE PUMP VALVE RESEATING MACHINE REFACING DISCHARGE VALVE SEAT OF DUPLEX STEAM PUMP.

The Man Below Cannot Do It All

Sturtevant
(Reg. Can. Pat. Off.)

Do not blame the engineer and the fireman if you cannot get all the steam you want—if the pressure goes down—if steam cannot be gotten up in a hurry. It is not all their fault. Your boilers are overloaded, and to get the extra steam you should install a

Sturtevant
(Reg. Can. Pat. Off.)

Turbo-Undergrate Blower

It will give you sufficient draft to get over peak load.
Granted that you have decided upon some blower, why not a Sturtevant? Mechanically it is superior to any other.
Take the bearings for instance. There are no ball bearings to rust, crack or give trouble, but instead there are generous bronze journals with oil-ring lubrication. The reservoirs are of ample capacity and will hold an oil supply that will last for several weeks.

Bulletin 214-U tells what the Sturtevant Blower will do. A copy is awaiting you.

B. F. Sturtevant Company of Canada, Limited

GALT, ONTARIO, CANADA

MONTREAL TORONTO WINNIPEG VANCOUVER

Selling Agents: Sanford Riley Stoker Co., Ltd., "THE RILEY STOKER"

AGENTS WANTED FOR CANADA

FOR

High Efficiency Centrifugal and Turbine Pumps

Design and Material of Highest Class

PRICES MODERATE

LARGE NUMBERS OF

Special Designs for Special Requirements

PULSOMETER ENGINEERING CO., LTD.

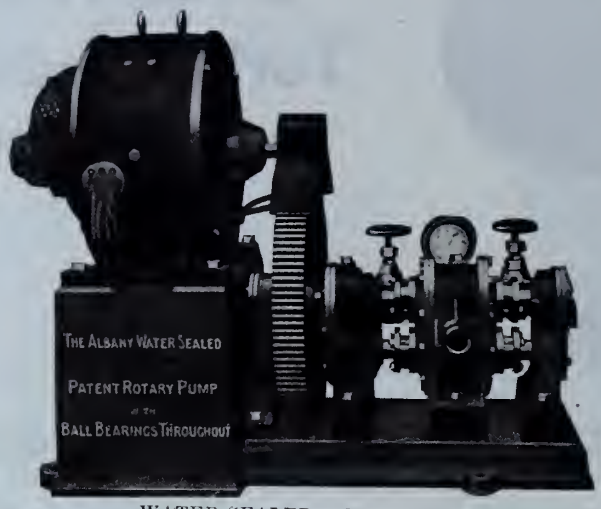
11 Tothill Street, LONDON **and** **Nine Elms Iron Works, READING**

If any advertisement interests you, tear it out now and place with letters to be answered.

and has two friction cups with hubs, on which can be mounted pulleys, cones, gears, etc., of various widths and diameters.

WATER SEALED ROTARY PUMP

THE Albany Pump Co., Toronto, are now building the Albany patent water-sealed rotary pump, which heretofore has been imported from London, England. The general design of this pump is similar to other rotary pumps on the market, in that it consists of a metal casing, inside of which revolve the impellers or wheels. The most important feature of this pump is the fact that slips and leakage have been reduced to a minimum by the introduction of grooves cut along the faces and edges of the teeth, so that in rotating a body of water lodges in the grooves forming an absolutely sealed water-tight joint or cushion between the casing and the rotating rollers, thereby producing an efficient vacuum. Centrifugal force also adds greatly to the efficiency of the pump.



WATER-SEALED ROTARY PUMP.

The pump is suitable for dealing with all kinds of liquids, the wheels and casings being made of different metals according to work for which it is required. Quite recently a pump was installed in Toronto for handling asphalt, which shows the wide range of application of such a unit.

The pump is designed for motor drive through a gear wheel and raw hide pinion, also for belt drive or by gasoline engine. In the latter case, the pump drive is through a roller chain, and not direct connected as formerly. The speed of the pump is the same for the medium and larger sizes, being 200 r.p.m., and the various outputs range from 700 to 60,000 gallons per hour. The speed of the smaller sizes, however, varies, the minimum capacity of the small pumps being 60 gallons per hour.

The "Albany" pump has achieved considerable success in pumping fuel oil, and several outfits have been placed in H. M. Dockyards, and are being largely used by the British and French Admiralties. After an exhaustive test, several of these pumps have been installed in H.M. submarines for pumping water from the trimming tanks.

BRITAIN'S MUNITIONS OUTPUT

THE remarkable increase in Great Britain's output of munitions is dealt with in an official statement just issued, which says:

"From time to time indications have been given of the enormous growth in the production of munitions in this country during the past 18 months. The supply of both guns and projectiles is increasing, as will be seen by the following figures, in which, from its importance in modern methods of warfare, artillery ammunition deserves first place. Taking as a basis for calculation, the average weekly production from the beginning of the war up to the end of June, 1915, the figures show the following rate of progress:

	(a)	(b)	(c)	(d)
18-pdr.	1	6½	17½	43
Field Howitzers (4.5 in.)	1	8	27	
Medium guns and howitzers	1	7½	34½	66
Heavy Howitzers (above 6 in.)..	1	22	94	323

(a) Weekly average at the end of June, 1915.
(b) Weekly average from July 1, 1915, to June 30, 1916.
(c) Week ending July 1, 1916.
(d) Week ending November 25, 1916.

"The improvement may be illustrated in a different way. We are now manufacturing in 8½ days the number of 75 m. m. shells which we were producing during the first year of the war—August, 1914 to August, 1915. The same quantity of projectiles for field howitzers is being supplied in eight days; that of projectiles for medium guns and howitzers in 5½ days, and that of projectiles for heavy guns and howitzers in a little more than one day. The number of shells completed or filled during the week of November 19-26 this year exceeded by about 30 per cent. the stock of munitions, held in reserve at the outbreak of hostilities.

Manufacture of Guns

"Dealing with guns in the same way, it is found that, representing the number of guns manufactured during the first year of war, the following increase have been secured:

	1st year	2nd year	July 31 to Nov. 29, 1916 (4 months)
18-pdr.	100	240	45
4.5 in.	100	654	104
Medium (60-pdr. and 6 in.).....	100	1,848	1,200
Heavy (over 6 in.)	100	623	363

"The manufacture of 18-pdr. guns has had to be slackened during the last period, the equipment of the British army in light field pieces being approximately complete.

"If the average monthly production of guns of all calibre be considered, a splendid development can be observed on comparing the results of the first year with those of the second period of 1916, as is seen from the following table:

	Monthly average for first year	Production during the five weeks ending Dec. 2, 1916
18-pdr.	100	128
Medium	100	4,100
Heavy	100	1,250

Large Increases Shown

"The improvement in the manufacture of machine guns, rifles, grenades and explosives has been equally satisfactory. If the total number of machine guns delivered to the army during the first year of the war be represented by 100, the total could be represented by 1,250 at the end of the second year and by 2,000 on December 2, 1916. Taking as a base the weekly production of machine guns in November, 1915, and representing it by 100, the corresponding figure for the weekly production in November, 1916, would be 410.

"The increase in the manufacture of explosives has been extremely rapid. For every ton of explosive employed in September, 1914, 350 tons were employed in July, 1915, and from 11,000 to 12,000 tons in July, 1916.

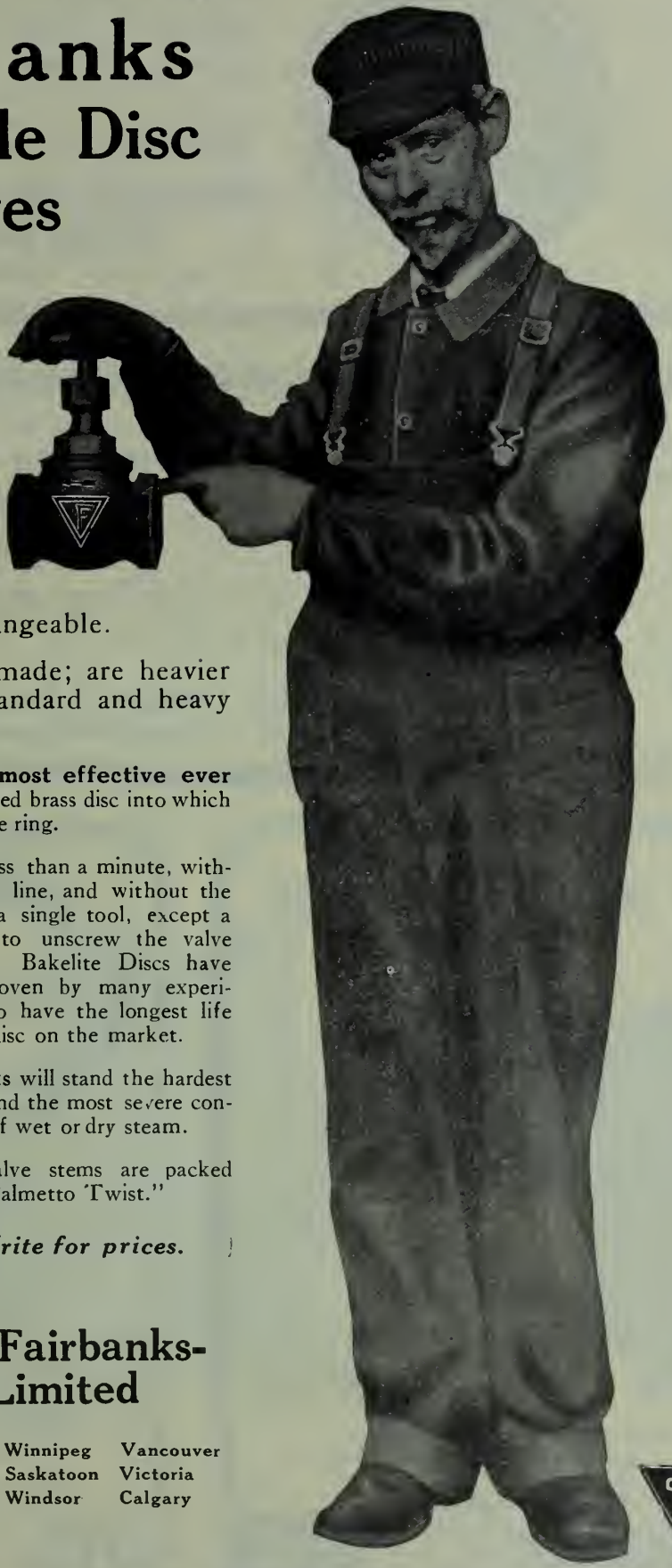
"Between May, 1915, and May, 1916, there was a 38-fold increase in bombs and a 150-fold increase in the weight of the contained explosive."

HIGH STEAM PRESSURES

THE principal advantage of a high steam pressure is the improvement in economy which it makes possible. Steam pressures could be safely increased considerably beyond present practice without any serious difficulties in the prime mover, be it either a steam turbine or a piston engine. The real limiting factor in present-day practice is the temperature. The maximum temperatures commonly employed in steam plants of today, 600 degs. Fah., cannot be exceeded without getting into difficulties with valves, fittings, packings and lubricants. It is interesting to note that a steam pressure of 600 lbs. still makes possible a superheat of 100 degs. Fah. without reaching the limit of 600 degs. total temperature. The entropy diagram readily reveals the amount of extra heat which can be recovered from the expansion of steam of 600 lbs. pressure, and 100 degs. superheat as compared with lower pressures. The total heat necessary to produce a pound of steam of 600 lbs. pressure and 100 degs. superheat is slightly less than that necessary to produce steam under 200 lbs. pressure and 200 degs. superheat. The amount of heat converted into work in adiabatic expansion, however, is 13.5 per cent. higher in the case of the high-pressure steam, both cases figured with the same final temperature and the same condenser pressure, about 28 in. of vacuum.

"Fairbanks Renewable Disc Valves

are strong in construction and service"



Every Engineer who has put them to a fair test will back up this statement.

In design they are very simple, containing few parts and all these interchangeable.

They are conservatively made; are heavier than the corresponding standard and heavy weights.

The Renewable Disc is the most effective ever produced. It consists of a recessed brass disc into which is spun a specially prepared Bakelite ring.

These discs can be replaced in less than a minute, without removing the valve from the line, and without the use of a single tool, except a wrench to unscrew the valve bonnet. Bakelite Discs have been proven by many experiments to have the longest life of any disc on the market.

Fairbanks will stand the hardest usage, and the most severe conditions of wet or dry steam.

The valve stems are packed with "Palmetto Twist."

Write for prices.

The Canadian Fairbanks-Morse Co., Limited

St. John	Ottawa	Winnipeg	Vancouver
Quebec	Toronto	Saskatoon	Victoria
Montreal	Hamilton	Windsor	Calgary

CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

AMERICAN GAUGES

Embody the latest improvements in gauge construction and insure steady accurate readings over a long period of years.

Sole Agents for Canada: CANADIAN FAIRBANKS-MORSE CO., LTD., Montreal, Toronto, Winnipeg.

American Steam Gauge and Valve Mfg. Co.

New York Chicago BOSTON Atlanta Pittsburgh

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

MARTELL PACKINGS MEAN MORE POWER

Up-to-the-minute Packing Service

Martell packings are not made like the ordinary kind.
They are cut at a tangent to the piston rod and joints on diametrically opposed sides of the piston are parallel. This arrangement of the joints of the ring allows the parts to adjust themselves to every slight inequality of wear in the diameter of the rod as they float freely. Friction and wear upon the rod are practically negligible.
No clearance for wear adjustments need be left between the ends, and sudden failure with this type of packing is impossible.
Use them once and you'll want them always.
Try them and see.

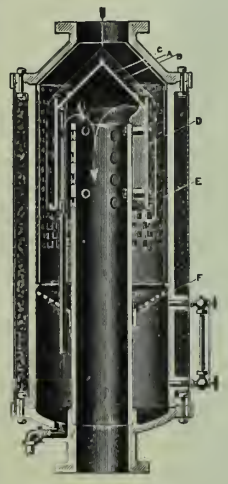
The Martell Packings Company, Inc., Elyria, Ohio

Canadian Agents: THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
820 Geddes Street - SYRACUSE, N.Y.

General Sales Agents:
Canadian Fairbanks-Morse Co., Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Vancouver, Victoria.

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited
St. John, Quebec, Montreal, Ottawa, Toronto Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

The quality that gives long service under hard conditions is being strictly maintained in

TRADE MARK

"PALMETTO" PACKING

REG. U.S PAT. OFFICE

It has a tensile strength unknown to other packings and each separate strand carries its own lubricant.

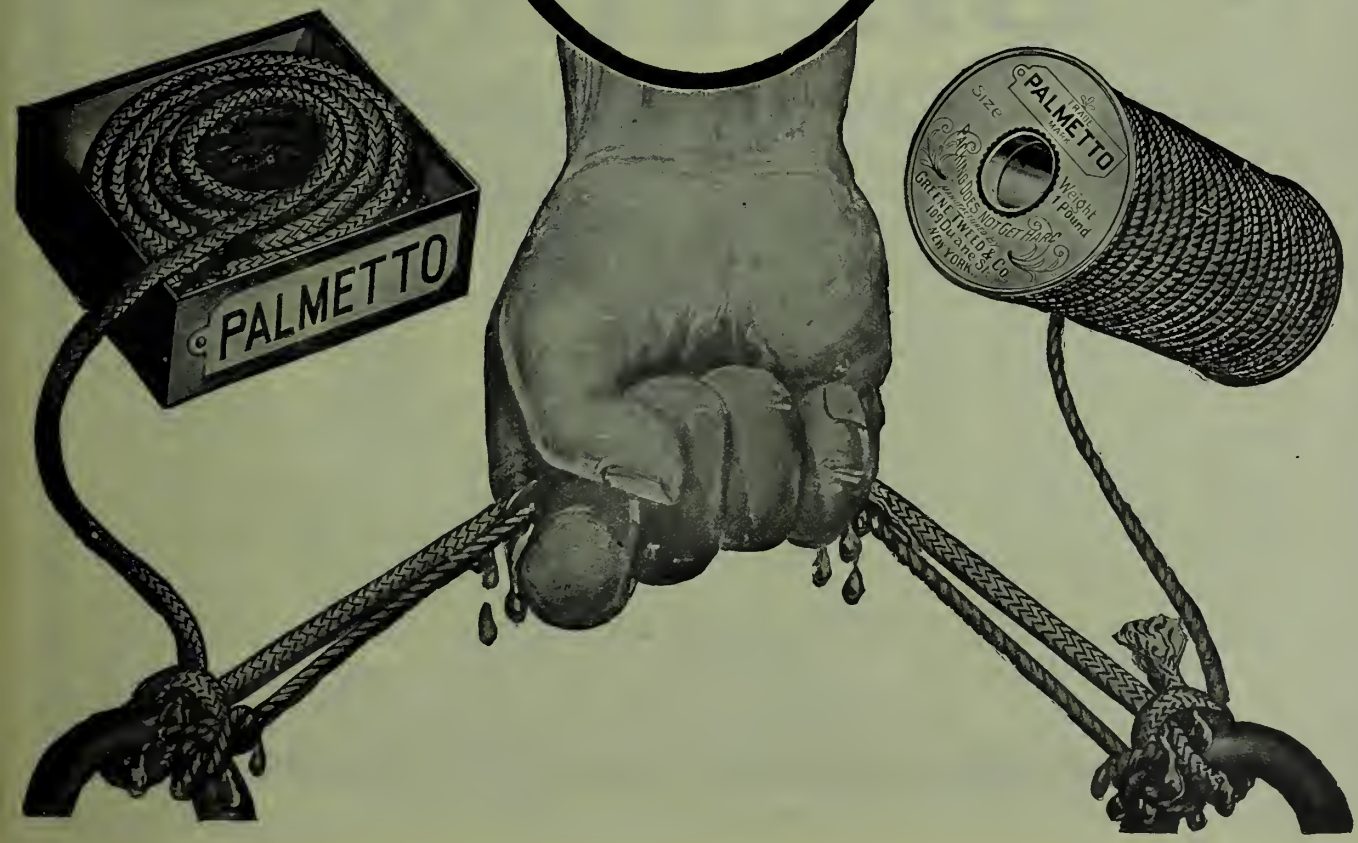
Let us send you free working samples to test.

Greene, Tweed & Co.

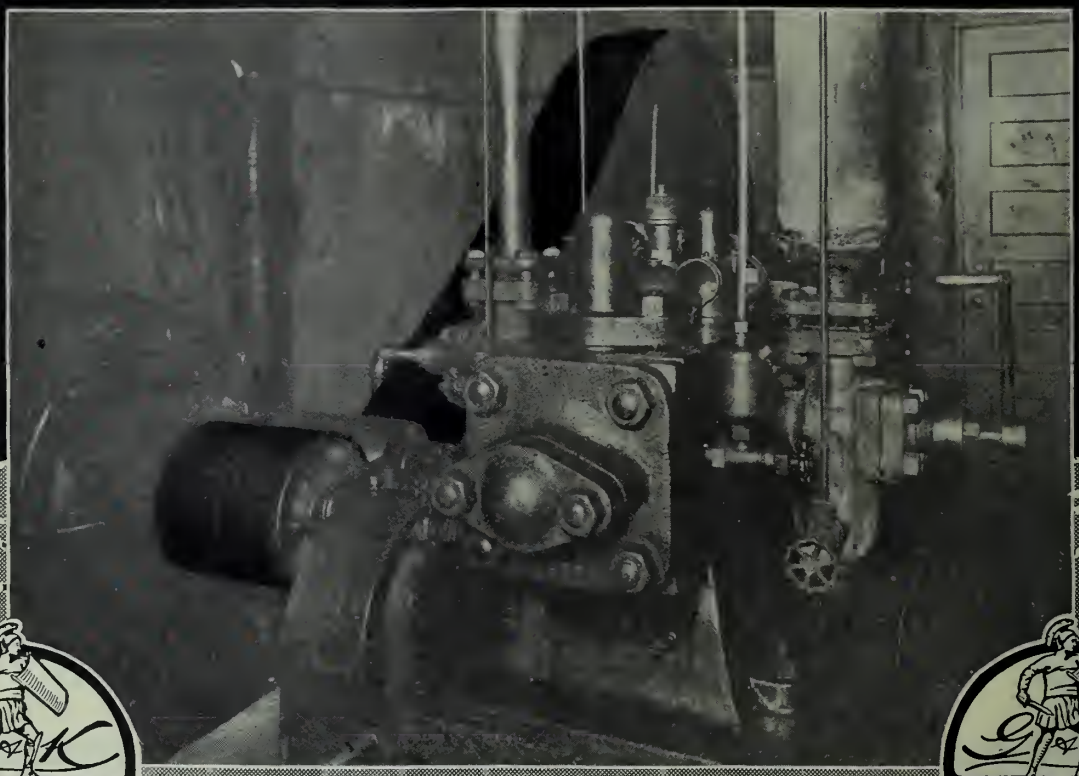
Sole Manufacturers

109 Duane St., NEW YORK

Representatives in Canada:
THE CANADIAN FAIRBANKS-MORSE COMPANY, Limited.
St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria.



SPARTAN



SPARTAN TRADE MARK REG U S PAT OFF

SPARTAN TRADE MARK REG U.S PAT OFF

BELTING

Driving Gas Compressor at Hotel Planters, Chicago, Ill.

Driving pulley 11½ inch diameter, 610 R.P.M. Driven pulley 79 inch diameter, 8 inch Lenix Idler, 8 ft. between pulley centers. 85 H.P.

Chief Engineer Klein says:—

"The Spartan Belt that you furnished for our twenty-five ton gas compressor is as good as new. We have run same about eighteen months, about sixteen hours per day.

"The belts we used before we had yours put on run us about eight months. Yours is good for a number of years more."

It's the pliability of Spartan Belting and its power of resistance to unusual operating conditions that make it the compressor belt of unequalled success. These same qualities assure you the utmost service from Spartan Belting—whether used on compressors or exposed to the steam, water and acid fumes of the bleachery, or to the extreme heat of the mercerizing room.

In short, Spartan is the belt for all difficult drives. Evidence of this is found in the new Spartan Book. It's a small book, but it shows Spartan Belting operating under a great variety of conditions. You will be interested to receive a copy, and it's yours for the asking.

THE GRATON & KNIGHT MANUFACTURING CO.

Oak Leather Tanners and Belt Makers

WORCESTER, MASS., U.S.A.

1851 G&K TRADE MARK

Canadian Agents: **The Canadian Fairbanks-Morse Company, Limited, St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria**

PRATT & CADY

VALVES

In New Montreal Filtration Plant

Illustration shows part of Control Gallery. In this room there are **16 Hydraulic Operated Pratt & Cady Valves.** These control the passage of air to the pipes below the sand bed for agitating the sand when cleaning, and are only a portion of an order for 128 valves built especially for this plant.

Pratt & Cady Valves were chosen because they have the reputation for absolute reliability under the most trying conditions.

These valves are easily operated, will take the pressure from either side and will not wedge. The stem and stem nut are of solid bronze, preventing rust or corrosion. A trial of these valves will give convincing proof of their superiority, especially in heavy service.

Pratt & Cady Valves are made in all styles and sizes for all purposes.

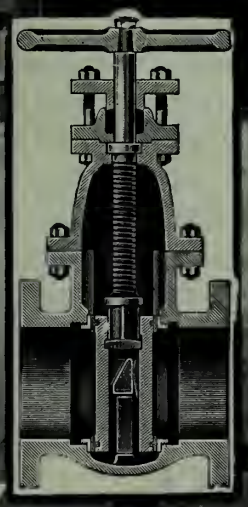
WE WILL GLADLY SEND YOU FULL INFORMATION ON REQUEST AND QUOTE PRICES ON RECEIPT OF YOUR SPECIFICATIONS.

Manufactured by PRATT & CADY Co., Inc., Hartford, Conn.

GENERAL SALES AGENTS:

CANADIAN FAIRBANKS-MORSE COMPANY, Limited

St. John Montreal Ottawa Toronto Hamilton
Quebec Calgary Edmonton Vancouver
Winnipeg Victoria



CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

The Publisher's Page

TORONTO January, 1917

Selling the Buyer

(No. 3 of a Series of Short Articles)

Educating Future Customers

NO manufacturer is in business to-day with the avowed purpose of retiring to-morrow. Rather do the majority wish to leave behind them, in their businesses, proud monuments to their earlier efforts and to their integrity and ability.

The importance of educating the coming superintendents and engineers will not be disputed by the far-seeing. It is perhaps a too seldom recognized truth in connection with advertising in reputable technical journals like THE POWER HOUSE, that future buyers can be educated while present sales are being influenced. We would like that thought to STICK.

As one leading manufacturer said to us not long ago in arranging for the use of increased space, "I have been thinking about our advertising a very great deal lately and I have reached this conclusion; that it would be nothing short of absolute folly for us to discontinue our advertising even temporarily. New men are coming into the field, new companies are being formed, new plants being erected. The firemen of to-day will soon be engineers. The superintendents of old plants will secure the same or higher positions in new plants. Changes are constantly taking place. I am signing cheques for firms from whom we ourselves are buying and who were not in existence when I did the buying, personally, a few years ago. If we wish to continue to be as well known as we are to-day, I am convinced we must continue to educate the future buyers through uninterrupted advertising."

THE POWER HOUSE
143-153 University Avenue - Toronto

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES.

Size.	Seamless	Lap-welded
1 in.	$30 00	....
1¼ in.	30 00	....
1½ in.	30 00	24 00
1¾ in.	29 00	21 00
2 in.	33 00	20 00
2¾ in.	33 00	....
2½ in.	35 75	26 50
3 in.	55 00	31 00
3¼ in.	54 50	36 00
3½ in.	59 50	39 00
4 in.	75 00	49 00

Prices per 100 feet, Montreal and Toronto.

BOILER PLATES.

	Montreal	Toronto
Plates, ¼ to ½	5 40	5 40
Heads	5 75	5 75
Tank plates, 3-16 in.	5 50	5 50

WROUGHT PIPE.

Buttweld.

Prices in effect Dec. 30, 1916.

Per 100 feet—	Black	Galv.
⅛ in.	$ 4 25	$ 5 75
¼ in.	3 54	5 67
⅜ in.	3 54	5 67
½ in.	4 59	6 16
¾ in.	5 64	7 76
1 in.	8 33	11 48
1¼ in.	11 27	15 53
1½ in.	13 48	18 56
2 in.	18 13	24 98
2½ in.	28 67	39 49
3 in.	37 49	51 64
3½ in.	46 92	63 94
4 in.	55 59	75 76

Lapweld.

2 in.	21 09	27 57
2½ in.	31 59	41 83
3 in.	41 31	54 70
3½ in.	51 52	68 54
4 in.	61 04	81 21
4½ in.	71 12	94 62
5 in.	82 88	110 30
6 in.	107 50	143 00
7 in.	142 80	186 80
8 in. L.	150 00	196 30
8 in.	172 80	226 10
9 in.	207 00	270 80
10 in. L.	102 00	251 20
10 in.	247 20	323 40

Prices Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES.

4" and under, 60%.

4½" and larger, 55%.

4" and under, running thread, 40%.

Standard couplings, 4" and under, 50%.

4½" and larger, 30%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 10%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 45; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse .....list plus 50%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL.

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	3.50
Steel bars, base, Toronto	3.75
Steel bars, 2 to 4 in. base	5 25
Iron bars, base, Montreal	3 25
Steel bars, base, Montreal	4 00
Reinforcing bars, base	3 55

SHEETS.

	Montreal	Toronto
Sheets, Black, No. 28	$5 00	$5 75
Sheets, Black, No. 10	5 50	5 60
Canada plates, dull, 52 sheets	5 75	5 75
Canada plates, all bright	6 30	6 50
Apollo brand, 10¾ oz. galvanized	7 25	7 25
Queen's Head, 28 B. W. G.	7 75	7 75
Fleur-de-Lis, 28 B.W. G.	7 45	7 35
Gorbal's Best, No. 28	8 25	7 50
Colborne Crown, No. 28	8 00	6 75
Premier, No. 28 U.S.	6 70	7 20
Premier, 10¾ oz.	7 00	7 50

PROOF COIL CHAIN.

¼ in.	$ 9 45
5-in in.	9 10
⅜ in.	8 35
7-16 in.	7 15
½ in.	6 95
9-16 in.	6 95
⅝ in.	6 80
¾ in.	6 70
⅞ in.	6 55
1 inch	6 40

Above quotations are per cwt.

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 25
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS.

	Per Cent.
Great Western, American	60
Kearney & Foot, Arcade	60
J. Barton Smith, Eagle	60
McClelland, Globe	60
Black Diamond	50
Delta Files	47½
Nicholson	50
Globe	57½
Vulcan	57½
Disston	60

OILS AND COMPOUNDS.

Castor oil, per lb.	25
Royalite, per gal., bulk	12
Machine oil, per gal.	25½
Black oil, per gal.	12½
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	0.6
Lard oil, per gal.	1.45
Union thread cutting oil antiseptic	68
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	10¾

BELTING—NO. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 50
Leather in sides	1 30

COAL AND COKE.

Solvay Foundry Coke	...
Connelsville Foundry Coke	...
Yough Steam Lump Coal	8 50
Pittsburgh steam lump coal	8 50
Best Slack	9 00

Net ton f.o.b. Toronto.

BOLTS, NUTS, AND SCREWS.

	Per cent.
Coach and lag screws	35
Stove bolts	55
Plate washers	20
Machine bolts, 7-16 and over	15
Machine bolts, ⅜ and less.	25
Blank bolts	15
Bolt ends	15
Machine screws, fl. and rd. hd. steel.	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd. brass.	add 20
Machine screws, o. and fil. hd., brass	add 25
Nuts, hex., up to 1 in., $3.75 per lb. off.	
Nuts, hex., over 1 in. $2.00 per lb. off.	
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	27½
Boiler rivets, base ¾ in. and larger	$5.25
Structural rivets, as above	5.15
Wood screws, flat, bright	75
Wood screws, O. & R., bright	70
Wood screws, flat, brass	42½
Wood screws, O. & R., brass.	40
Wood Screws, flat, bronze.	35
Wood screws, O. & R., bronze	32½

MISCELLANEOUS.

Solder, guaranteed	0 28½
Solder, strictly	0 25½
Babbitt metals	11 to 60
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	3 00
White lead, pure, cwt.	14 25
Red dry lead, 100-lb. kegs, per cwt.	12 87
Glue, French medal, lb.	0 25
Tarred slaters' paper, roll.	0 95
Gasoline, per gal., bulk	0 28½
Benzine, per gal., bulk	0 27½
Pure turpentine, single bbls., gal.	0 71
Linseed oil, raw, single, bbls.	1 12
Linseed oil, boiled, single bbls	1 15
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	8 00
Packing square braided	0 27
Packing, No. 1 Italian	0 32
Packing, No. 2 Italian	0 25
Lead wool, per lb.	0 12
Pure Manila rope	0 25¼
Transmission rope, Manila	0 29½
Drilling cables, Manila	0 28½

COPPER PRODUCTS.

	Montreal	Toronto
Bars, ½ to 2 in.	$46 00	$46 00
Plain sheets, 14 oz., 14x28 in., 14x60 m	45 00	45 00
Copper sheet, tinned, 14x60, 14 oz.	54 00	54 00
Copper sheet, planished, 14x60 base.	57 00	57 00
Braziers' in sheets, 6x4 base	46 50	46 50

BRASS PRODUCTS.

Brass rods, base ½ in. to 1 in rd.	0 55
Brass sheets, 8 in. wide, 20 oz.	0 60
Brass tubing, seamles	0 55
Copper tubing, seamless	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto 25%

RUBBER BELTING.

Staudard	50%
Best grades	30%

WASTE.

White	Cents per lb.
XXX Extra	18
Peerless	18
Grand	17
Superior	17
X L C R	16
Atlas	16
X Empire	15
Ideal	15
X press	14

COLORED.

Lion	12½
Staudard	11
No. 1	11
Popular	10
Keen	09

WOOL PACKING.

Arrow	24
Axle	18
Anvil	14
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	40
Sq. & Hex. Head Cap Screws	30
Rd. & Fil. Head Cap Screws.	15
Flat & But. Hd. Cap Screws plus	15
Fin. & semi-fin, nuts up to 1 in.	30
Fin. and semi-fin. nuts, over 1 in.	25
Studs	15
Taper pins	45
Coupling bolts, plus	15
Planer head bolts, without fillet	15
Planer head bolts, with fillet	net
Planer head bolt nuts, up to 1 in.	30
Planer head bolt nuts, over 1 in.	25
Planer bolt washers	plus 10
Hollow set screws	list plus 40
Collar screws	list plus 20
Thumb screws	20
Thumb nuts	70
Patch bolts	add 65
Cold pressed nuts to 1½ in.	add 3.50
Cold pressed nuts over 1½ in.	add 2.00

METALS.

	Montreal	Toronto
Lake copper	$36 00	$36 00
Electro copper	36 00	36 00
Castings, copper.	35 00	36 00
Tin	47 00	47 00
Spelter	13 50	13 50
Lead	10 00	9 50
Antimony	15 00	18 00
Alumiuum	70 00	68 00

Prices per 100 lbs.

LEAD SHEETS.

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$12 00	$12 50
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Projects and Developments

TRADE GOSSIP

Brantford, Ont. — The City Council contemplate installing a mechanical filltration plant.

Toronto, Ont.—The Gutta Percha & Rubber Co. will build an extension to their power house.

Pembroke, Ont.—The Pembroke Electric Light Co. propose building a hydro-electric power plant.

Aylmer, Ont. — The Town Council contemplate purchasing additional power equipment. Gas engines may be installed.

Amherst, N.S.—The Town Council contemplate the purchase of a motor-driven centrifugal pump in connection with the waterworks system.

Niagara Falls, Ont.—The Pure Ice & Cold Storage Co., has let contract for erection of a 10-ton ice making plant to be ready for operation by March 1, 1917.

Lindsay, Ont.— Plans for rebuilding the cold storage plant of Flavelles, Ltd., are being prepared by the Madison Cooper Co., New York City. It will cost $75,000.

Winnipeg, Man.—The Ontario & Manitoba Cold Storage Co., it is reported, will build a cold storage warehouse to cost about $100,000 in the near future.

Markham, Ont.—By a vote of 96 to 8 the ratepayers on Jan. 1, endorsed the proposition to expend the sum of $6,000 on the extension of the present waterworks system.

Toronto, Ont. — The Township of Etobicoke propose to construct a waterworks system at an approximate cost of $75,000. E. A. James, of Toronto, is the consulting engineer.

East Bella Bella, B.C.—The Gosse-Millerd Packing Co., has had installed a 7-ton ammonia compressor which was furnished by the Armstrong Machinery Co., Spokane, Wash.

The S. K. F. Ball Bearing Co., Hartford, Conn., are reorganizing their Canadian branch the S. K. F. Ball Bearing Co., and have opened offices at 47 King Street West, Toronto.

The Frick Ice and Refrigeration Co., Montreal, have been awarded a contract by Canadian Explosives, Ltd., Montreal, for an 8-ton refrigerating machine, to be installed at Nobel, Ont.

Cayuga, Ont.—It is proposed to install a steel water tank, gas engine and pump, etc., in connection with the waterworks system. Jackson & Lee, Brantford are the engineers.

The Frick Ice and Refrigeration Co., Montreal, have sold a 15-ton refrigerating machine to Curtis & Harvey, Ltd., Rigaud, Que., and a 10-ton machine to the Elmhurst Dairy, Montreal.

Port Colborne, Ont.—Contract for turbines and generators required for the new plant being erected by the International Nickel Co., has been awarded to the Ridgeway Engine & Dynamo Co., New York.

Toronto, Ont.—The Board of Control recommends that the Works Department be authorized to purchase the following suplies during 1917 in the open market: Iron and steel, pig lead, paving pitch, pipe and boiler tubes, rubber valves, etc.

Philip J. Duff, who for over two years has been resident engineer for the John verMehr Eng. Co., on the construction of the new filtration plant, Toronto, has resigned his position to accept an appointment on the inspection staff of the Imperial Munitions Board, Ottawa.

St. Lambert, Que.—Tenders will be received up to January 22, for the supply of a horizontal shaft centrifugal pump, electric motor and switchboard. Specifications may be obtained from H. A. Gibeau, Town Engineer, Town Hall, St. Lambert, Chambly Co., P.Q.

The Duncan Electric Co. has been incorporated at Ottawa with a capital of $150,000 to manufacture and deal in electrical apparatus and supplies of all kinds at Montreal. Incorporators are J. H. Meagher, Henry W. Chauvin and James E. Coulin, all of Montreal.

Winnipeg, Man.—Tenders will be called until Feb. 12, 1917, for works required for the completion of the new Parliament Buildings which include the following, Heating and ventilating, electric conduit and wiring. Thos. H. Johnson, Minister of Public Works, Winnipeg.

The Turbine Equipment Co., C.P.R. Building, Toronto, has been awarded a contract by the town of Mimico, Ont. to supply and install three "De Laval" pumps at the sewage disposal plant. Two pumps will be direct connected to Canadian Westinghouse motors and the third unit to a 40-h.p. gasoline engine.

The Spencer Heating Co., of Canada, Ltd., has been incorporated at Ottawa, with a capital of $500,000, to manufacture boilers, heaters and furnaces of all kinds, with head office at Toronto. The incorporators are: Tilman H. O'Neil, Albert T. Hawley, and Hugh Polson, all of Winnipeg.

South Bay Power Co. has been incorporated at Toronto, with a capital of $1,000,000, to operate power plants in the Sudbury and Temiskaming districts of Ontario, with head office at Toronto. Provisional directors are: A. Fasken, G. H. Sedgwick, and Duncan McArthur, all of Toronto.

Sub-Lieut. Andrew Dyas MacLean has been granted a commission in the Royal Naval Volunteer Service, and is at the present time taking a course at Greenwich. He is a son of Major Hugh C. MacLean, of the Hugh C. MacLean Publishing Co., Toronto and Winnipeg. The young officer went to England to join the motor-boat patrol service.

D. M. Medcalf, chief inspector of boilers for the Province of Ontario, has returned from New York and Washinging, D.C., where he attended meetings called for the purpose of discussing the proposed A.S.M.E. code of boiler rules and regulations. The meeting in Washington was called by the Industrial Commission of Ohio, and the New York meeting by the American Society of Mechanical Engineers.

Hugh McCulloch, one of Galt's most prominent residents, died there on January 8, in his sixty-first year. He was president of the Goldie & McCulloch Co., vice-president of the Galt Malleable Iron Co., and of the Galt Art Metal Co., and a director of the Gore Mutual Fire Insurance Co. A native of Galt, he was closely identified with the industrial progress of the city, but never held municipal office. He was educated at Whitby Grammar School and Upper Canada College.

The Turbine Equipment Co., Toronto, have obtained a contract from the Town of Cornwall, Ont., to supply and instal two 10-in. De Laval single-stage pumps, each of which will have a capacity of 3½ million gallons a day against 180 ft. head when operating individually; 7 million gallons a day against 180 ft. head when operating in parallel, and 4½ million gallons a day against 310 ft. head when connected up in series. This installation is somewhat unique, inasmuch as the pumps will be driven by hydraulic turbines, which will be supplied by the Wm. Kennedy Co., of Owen Sound. The speed of these turbines will be 200 r.p.m., and to enable a speed of 1,650 r.p.m. being attained on the pumps a set of De Laval double helical gears will be installed between each turbine and pump. The contract price of the pumps was $10,075, which includes a few valves and some piping. The price of the hydraulic turbines was $5,000 each.

CATALOGUES

The Cling-Surface Co., 1057 Niagara Street, Buffalo, N.Y., have issued a very unique calendar of special interest to engineers and will gladly send a copy of anyone who applies to them.

Mechanical Stoker.—Bulletin B-2 deals with the type "E" underfeed stoker made by the Combustion Engineering Corporation, New York. The bulletin contains a full description of this stoker, particular attention being given to the principal features embodied in its design and operation. The illustrations show sectional views of the stoker and installations under various types of boilers.

A Chain of Evidence is the title of publication No. 15, issued by the Morse Chain Co., Ithaca, N.Y. This bulletin, although bearing a sub-title, "Small Power Drives," is not confined to small drives, but includes drives up to 100 h.p. The bulletin deals with the characteristics, design and efficiency of the "Morse" silent chain drives and contains a number of illustrations covering a variety of installations which feature the wide field of application. A data sheet is included for use in the design of "Morse" silent chain drives.

Crossley Oil Engines.—A bulletin dealing with the new Crossley oil engine for running on crude, residual and refined oils, has been issued by Crossley Bros., Ltd., Openshaw, Manchester, England. The bulletin contains full details covering the design of this engine and its attachments, while the advantages claimed for it are given in detail. Reference is made to the economical fuel consumption of the engine, and its adaptability for burning various qualities of crude and residual oils. Details of a test on a 95 b.h.p. engine are included. The bulletin is fully illustrated.

Ammonia Fittings and Supplies.—The Canadian Ice Machine Co., Toronto, are distributing a new high class catalogue, dealing with the "York" ammonia fittings and supplies. This catalogue, which supersedes all pervious issues, illustrates and describes standard types of fittings, etc., for which patterns are already made. A complete line of fittings and supplies is dealt with as used in refrigeration plants, the first part being devoted to fittings and the second covering various types of condensers, ammonia receivers, coolers, distillers, oil and steam separators, brine coolers, and filters, etc. An extensive line of valves and fittings are illustrated, accompanied by tables giving the principal dimensions for each size. The concluding pages contain views of numerous installations featuring various types of "York" refrigerating machines. The catalogue contains 132 pages, with exceptionally good half tones. Copies may be had on application by interested readers.

BOOK REVIEWS

Graphical Solutions of Electric Railway Problems.—In an effort to overcome the difficulties attendant upon the use of analytical methods in the solution of electric railway problems involving the characteristics of motive power, A. M Buck, of the Engineering Station, University of Illinois, has developed a series of graphical methods which supply an accurate and easy means of attack applicable to any possible combination of electric motor characteristics and any range of conditions which may be met in practice. Diagrams have been developed to set forth the relationship between motor current and speed, between current and tractive effort, between speed and tractive effort, between speed and time, etc. The results of Professor Buck's studies are set forth in Bulletin No. 90 of the Engineering Experiment Station. Copies may be obtained on request from W. F. M. Goss, Director, Urbana, Illinois.

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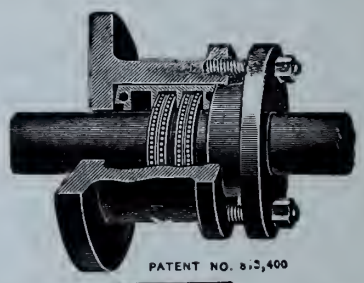

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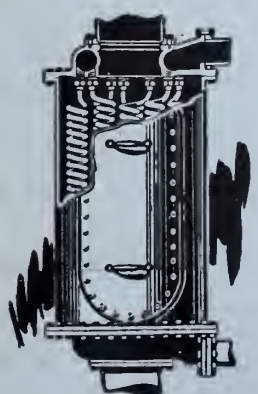

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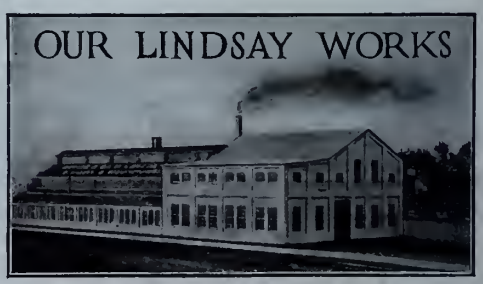

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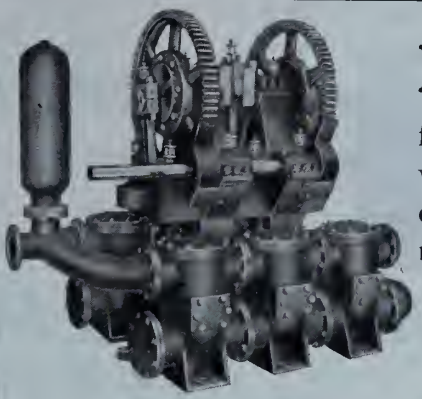

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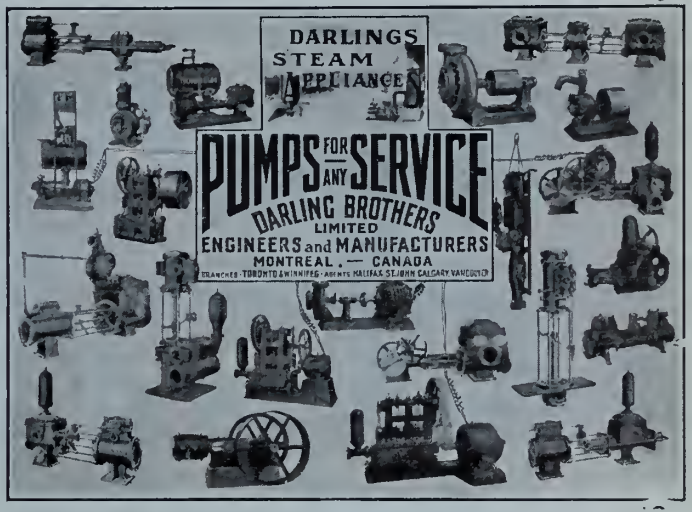

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Waterous Engine Works Co., Brantford, Ont.

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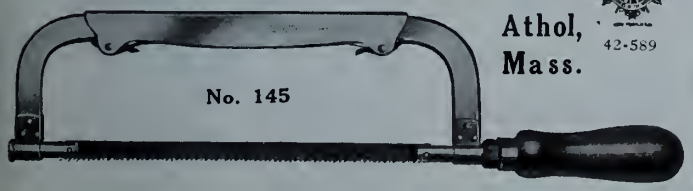

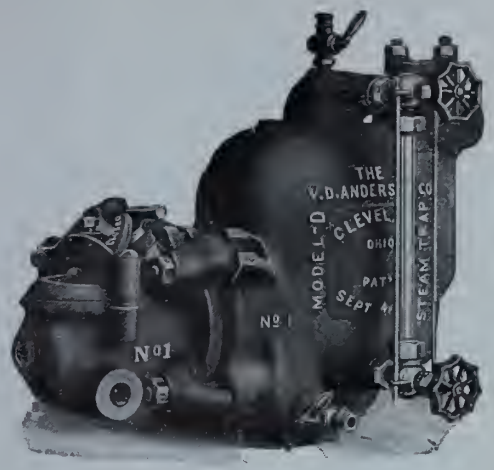

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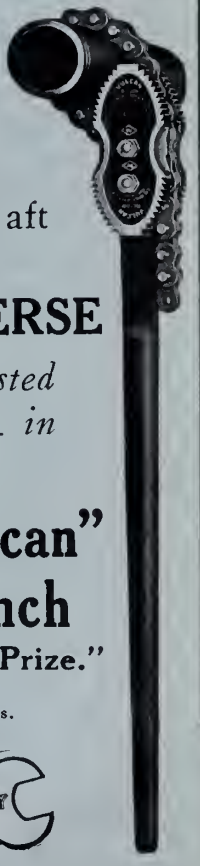

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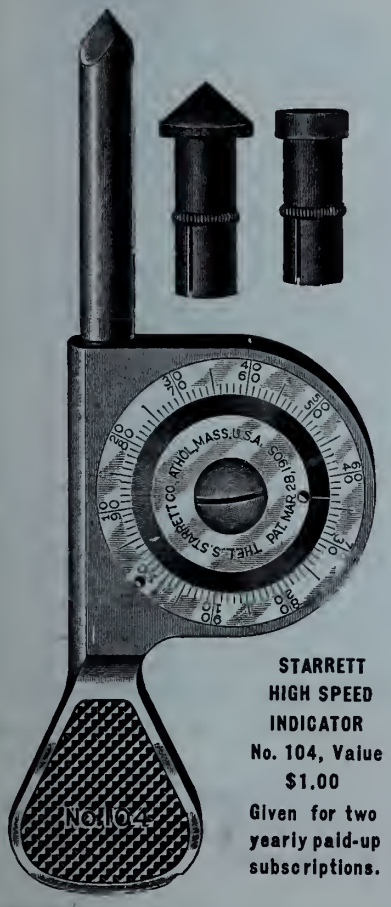

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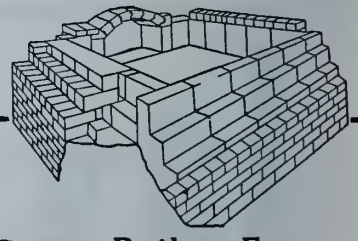

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When writing advertiser kindly mention that you saw his ad. in this paper.

If any advertisement interests you, tear it out now and place with letters to be answered.

MACLEAN'S MAGAZINE *for* February

Just suppose you were made Editor of MACLEAN'S MAGAZINE for one issue!

WHAT would you provide for your readers? You would probably want some good short stories, and you would like to offer chapters of a good serial. You would want something in lighter vein. Perhaps some verse. Certainly some serious articles of an informative and critical nature. Probably you would want everything—contributions and illustrations—to be by Canadians. Good! But who are they? And could you get their work?

Look at what the regular editor, T. B. Costain, has provided for the February issue of MACLEAN'S:

A serial story by **Sir Gilbert Parker**—"Jordan is a Hard Road."

A short story by **H. G. Wells**—"Into the Abyss."

A complete novelette by **A. C. Allenson**—"Danton of the Fleet."

A gripping sketch of "The Greatest Hotelman in the World"—a Canadian, by name John McE. Bowman, of the Hotel Biltmore, New York; and the man behind the Manhattan Hotel, New York, and the hotel now building in the same city, The Commodore, and the new Canadian hotel, The Devonshire, to be built this year in Toronto. **W. A. Craick** gives the story of this remarkably successful and interesting man—a veritable romance of achievement.

Stephen Leacock is in the February MACLEAN'S with one of his inimitable sketches—this one entitled—"In Merry Mexico." What a fancy, what a humor this man has! He roams the earth, and always is visiting some land or country in the spotlight of the world's history.

Then Editor Costain has **Miss Agnes C. Laut** in the February issue with a timely and thought-provoking article, "The Elections and Canada." She is writing of the American elections of last November, and in her virile style and with her amazing inside knowledge of things political, she gives all Canadians much to think about, and a wider vision of the place Canada holds in world affairs—dwelling especially on the new Anglo-Saxon relations which will be the result of the war now being waged, and which gives promise of involving the United States. Miss Laut's contribution is well worth reading.

H. F. Gadsby, free lance, ever a-tilting at politicians and politics, and never failing to get under the guard of parties and partisans, writes sparklingly on "How Premiers Control Their Cabinets" — of piquant interest in view of Sir Sam Hughes's recent encounters with Premier Borden. Gadsby studies other Canadian Cabinets than those of Premier Borden's. Good reading, this.

Then Editor Costain starts in this February issue of MACLEAN'S a new department—snappy biographical sketches and zestful stories of notable and interesting Canadians. You will enjoy this yourself and so will all others to whom you may introduce MACLEAN'S MAGAZINE.

The usual departments—Review of Reviews and "Information for Investors"—are present as usual; and illustrations by these Canadian artists, C. W. Jefferys, Harry C. Edwards, Lou Skuce, E. J. Dinsmore, assist to give the February MacLean's *distinction and appeal.*

Now if you have been keeping in mind yourself—as a possible editor of MACLEAN'S MAGAZINE for a single issue—do you think you could excel or equal what the regular editor has provided for MACLEAN'S readers?

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and unduly taxes your auxiliaries and a lower pressure would operate them more efficiently and economically, a

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INDEX TO ADVERTISERS

A

	PAGE
Albany Lubricating Co.	23
American Pulley Co.	15
American Steam Gauge & Valve Mfg. Co.	58
American Steam Pump Co.	29
Anderson Co., V. D.	71
Armstrong Cork Insulation Co.	25

B

	PAGE
Babbitt Steam Specialty Co.	20
Bawden Machine Co., Ltd.	29
Babcock & Wilcox	68
Boiler Inspection Dept.	14
Boving Hydraulic & Eng. Co.	66
Bowser, S. F., & Co., Inc.	30
Brown Hoisting Machy. Co.	9

C

	PAGE
Can. B. K. Morton Co.	19
Can. Detroit Lub. Co.	23
Can. Fairbanks-Morse Co.	57
Can. Griscom-Russell Co., Ltd.	66
Can. Morehead Mfg. Co.	72
Can. Sirocco Co.	28
Chaplin-Fulton Co.	8
Cling-Surface Co.	23
Coppus Eng. & Equip. Co.	7
Crown Mfg. Co.	12

D

	PAGE
Darling Bros.	67
Dart Union Co.	13
Davis Regulator Co.	78
D'Este Co., Julian	9
De Laval Steam Turbine Co.	28
Direct Separator Co.	58
Dixon Crucible Co., Jos.	76
Dominion Belting Co.	20
Dominion Coal Co.	60

E

	PAGE
Economy Fuse & Mfg. Co. of Canada	9
Elliot Company	53
Escher Wyss & Co.	30

F

	PAGE
Federal Engineering Co.	67
Francis, Walter J. & Co.	76
Foxboro Co.	75
Frick Co.	26

G

	PAGE
Galt Foundry Co.	4
Garlock Packing Co.	16
Garth Co.	66
Gates, John W.	76
Goldie & McCulloch Co.	32
Graton & Knight Mfg. Co.	68
Greene, Tweed & Co.	59

H

	PAGE
Hoffman, G. W.	76
Holmes Metallic Packing Co.	66
Homestead Valve Mfg. Co.	7
Hoyt Metal Co.	2

I

	PAGE
Inglis Co., John.	Inside back cover

J

	PAGE
Jamison Cold Storage Door Co.	26
Jeffrey Mfg. Co.	18
Jenckes Machine Co.	2
Jenkins Bros.	5
Jones Underfeed Stoker Co., Ltd.	10

K

	PAGE
Kerr Engine Co.	11
Kerr Turbine Co.	30

L

	PAGE
Ladd, The Geo., Co.	67
Laurie & Lamb	27
Linde Canadian Refrigeration Works Co.	24
Lunkenheimer	11

M

	PAGE
MacGovern & Co.	73
MacKinnon, Holmes & Co.	76
Magnolia Metal Co.	18
Martel Packings Co.	58
Mason Regulator Co.	6
McAvity & Sons, T.	8
McDougall Caledonian Iron Works Co.	21
McGhie, W. C.	66
McLaren, D. K., Ltd.	19
Morris Machine Works	28
Morrison Brass Mfg. Co., Jas.	Outside back cover
Morse Chain Co.	21
Murphy Iron Works	4

N

	PAGE
Nashua Mach. Works	6
National Steam Pump Co.	29

O

	PAGE
Oster Mfg. Co.	67

P

	PAGE
Peerless Rubber Co.	Inside front cover
Peiler & Co., H. L.	6
Penberthy Injector Co., Ltd.,	Outside front cover
Pennsylvania Flexible Metallic Tubing Co.	58
Perolin Co., of Canada	10
Pierce Co., Wm. B.	14
Polson Iron Works	3
Pratt & Cady Co.	61
Pulsometer Engineering Co. N	55

R

	PAGE
Roto Company, The	20

S

	PAGE
Sarco Co., Inc.	65
"S-C" Regulator Co., The	8
Seaife, Wm. B., & Sons Co.	76
Schaeffer & Budenberg Mfg. Co.	7
Smart-Turner Mach. Co.	67
Smith, Fred	14
Snowden, C. C.	22
Spray Engineering Co.	68
Starrett, L. S., Co.	71
Steel Mill Packing Co.	67
Storey Pump & Equipment Co.	28
Sturtevant B. F., Co., of Canada	55

T

	PAGE
Taylor Instrument Co.	75
Thomas Grate Bar Co.	4
Trimont Manufacturing Co.	73
Turbine Equipment Co., Toronto	28

U

	PAGE
Uehling Instrument Co.	71

V

	PAGE
Vilter Mfg. Co.	24

W

	PAGE
Wall, W. J.	65
Waterous Engine Works Co.	1
Watson & McDaniel Co.	66
Williams & Co., J. H.	73

Y

	PAGE
York Mfg. Co.	25

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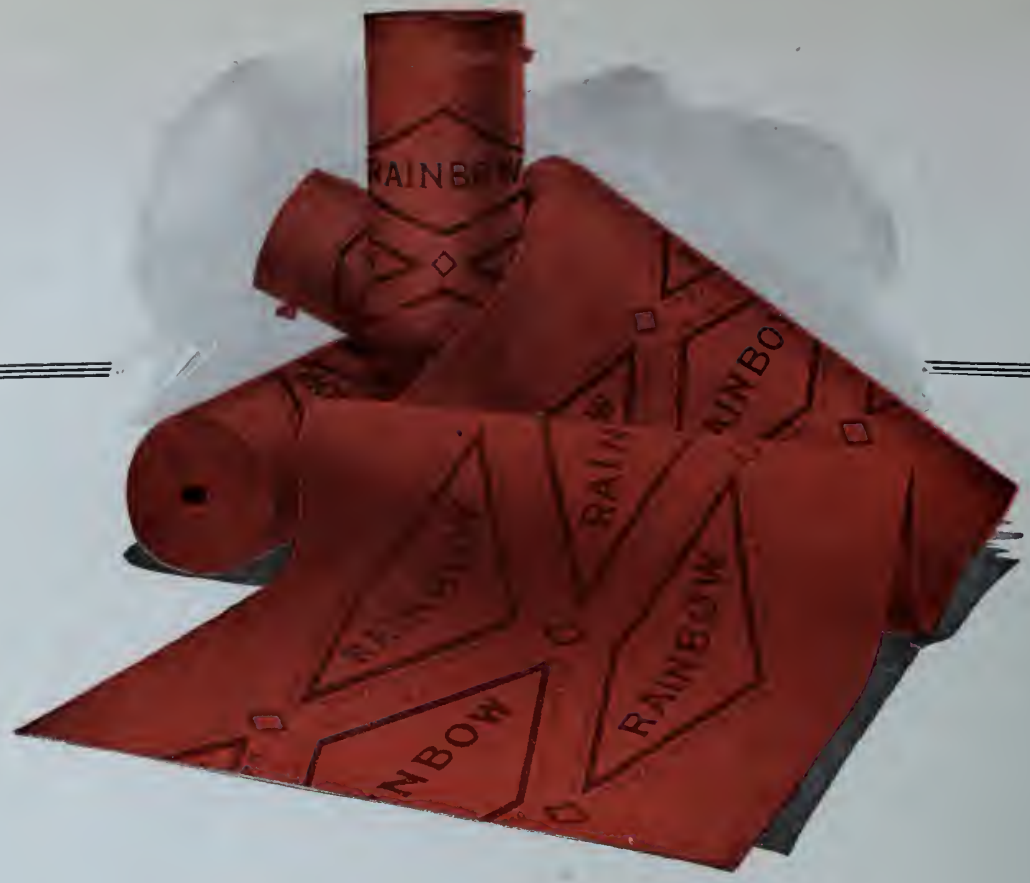

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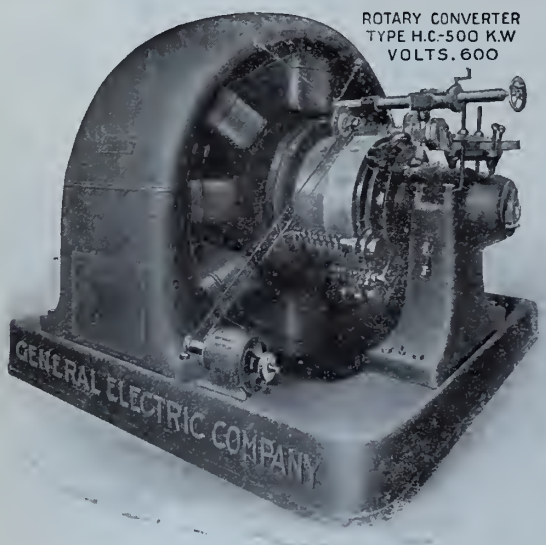

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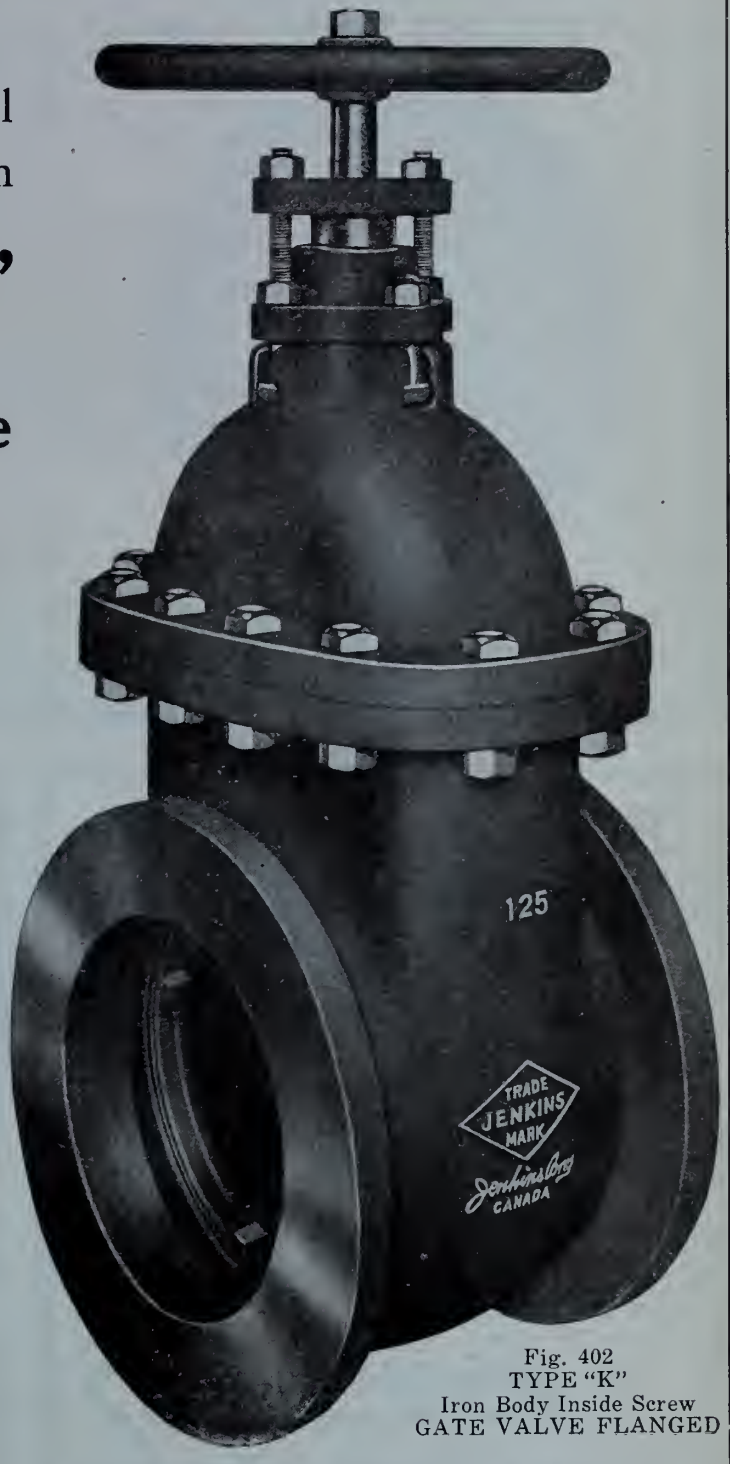

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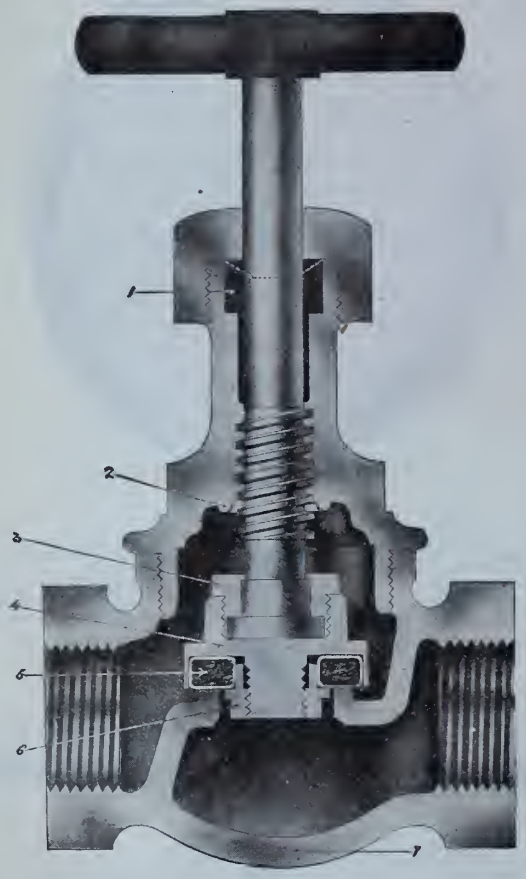

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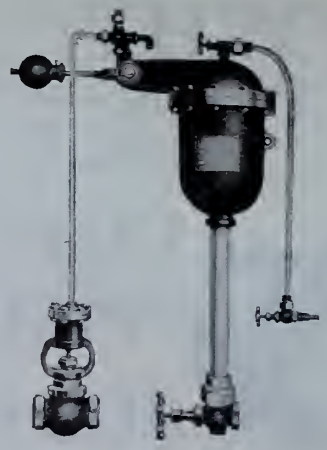

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KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

If any advertisement interests you, tear it out now and place with letters to be answered.

You Pay for Results

You are not called upon to pay one cent for

"Imperial" Boiler Coating

until it has proved to your satisfaction that it's a positive remedy for boiler scale troubles.

Imperial Boiler Coating is not a boiler compound

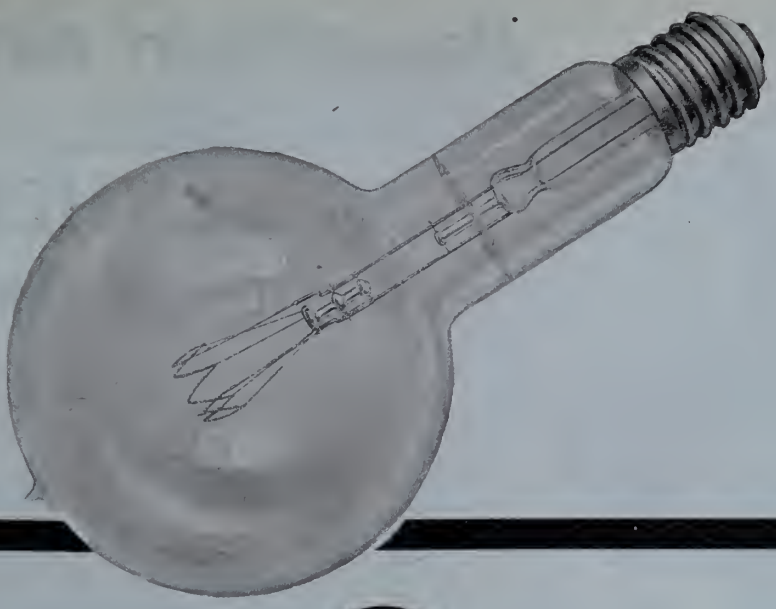
It contains in highly concentrated form all the best chemicals and vegetable extracts known for removing scale, combined with a peculiar paint or coating which forms on the boiler metal and resists all scale formation and pitting. No acids, graphite, or other harmful ingredients are used.

We know from practical experience of all users that our method of boiler treatment for scale prevention is absolutely satisfactory, and so confident are we of this fact that we have made the above offer of "Satisfaction or no pay."

WRITE US TO-DAY.

Crown Manufacturing Co.

CLEVELAND, OHIO



Laco Quality

MR. LAMP USER—You exercise great care in selecting machines for your plant—why not do so in selecting your electric lamps?

LACO NITRO LAMPS are an investment that pay big dividends in the form of *50% increase* in light over the Tungsten and *five times* the light of a carbon lamp. Same consumption of current.

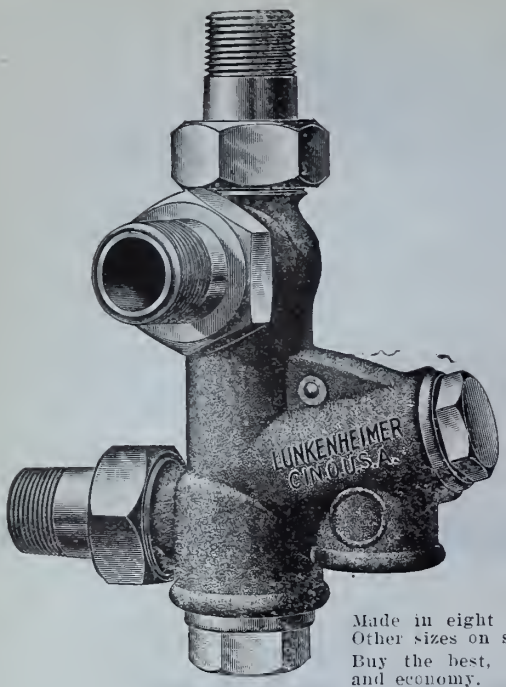
Let the lamps themselves prove their quality. Start cutting lighting costs now. Put a LACO NITRO LAMP in every socket.

Ask your dealer for quotations.

Canadian Laco-Philips Company, Ltd.

Montreal Toronto Winnipeg Vancouver

If any advertisement interests you, tear it out now and place with letters to be answered.



Results in service—

prove the efficiency, delivering capacity and durability of the

LUNKENHEIMER Automatic Injector

Users everywhere proclaim the merits of this simple, yet efficient boiler feeder.

It excels all others because **it will deliver more water per pound of steam, is absolutely automatic at all times, and will restart instantly after a temporary interruption of either the steam or water supply.**

Its capacity is diminished in a lesser degree by long lifts and hot feed water, and the amount of water delivered can be graded over fifty per cent.

The correct design of the tubes and large areas through the body account for its excellent performance; the special hard bronze composition used, for its durability. All parts are made to gauge and are renewable.

THE LUNKENHEIMER EJECTOR is an efficient machine for raising water from pits or deep wells, filling or emptying tanks, etc. It embodies the **same excellence in design, high quality material and workmanship** as the injector.

Made in eight sizes, capacities 250 to 11,000 gallons per hour. Other sizes on special order.

Buy the best, viz., "Lunkenheimer"—for efficiency, satisfaction and economy.

Your local dealer can furnish them; if not, write us.
Write for Booklet No. 504-DC.

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High-Grade Engineering Specialties in the World

New York Chicago **CINCINNATI, O., U.S.A.** Boston London

19037-9-43

The Boiler Room is where power plant economy must begin, and with that big item of expense—COAL

The little leaks and wastes that get your attention in the engine room, though deserving, are insignificant, compared to the preventable waste under your boilers.

THE JONES UNDERFEED STOKER

is a **BIG** paying investment in the small plant, and a **BIGGER** paying investment in the larger plant.

Fuel savings of from 15 to 25% over previous hand fired methods.. are what Jones Stokers are doing in hundreds of BOILER ROOMS. Consider what these savings mean!

LOOK AGAIN AT YOUR COAL BILL!

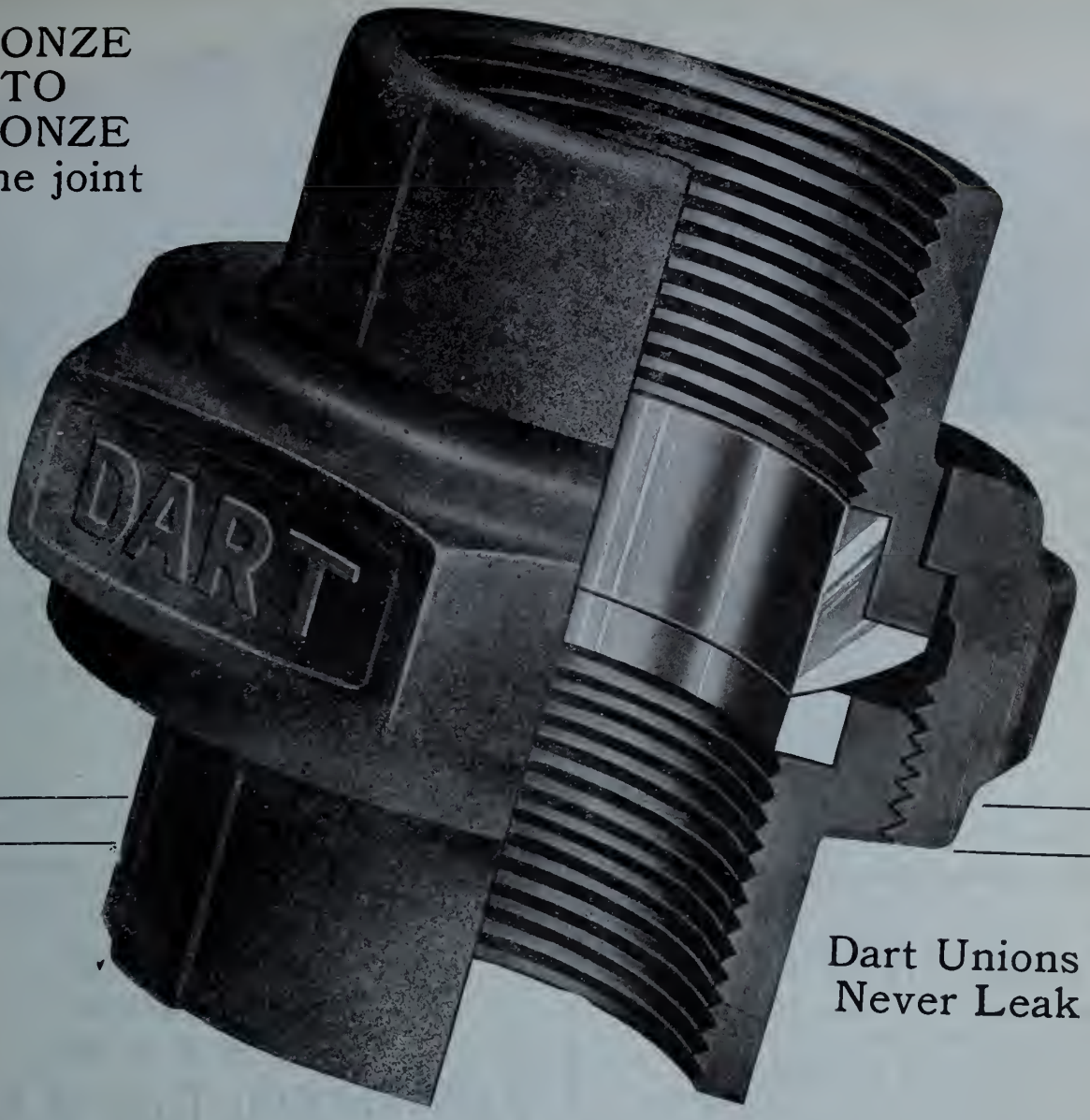
Have us investigate the conditions in your plant. If your boiler is not suitable for an equipment, we will readily tell you so, and you will be under no obligation to us.

Ask for Catalog.

Jones Underfeed Stoker Co.,
Limited

National Trust Building - TORONTO

BRONZE
TO
BRONZE
at the joint



Dart Unions
Never Leak

Your Protection Against Pipe Coupling Trouble

Dart Unions cannot loosen up and leak. They have **Bronze to Bronze seats.** No deterioration at the vital point is possible. Heavy iron parts will not stretch or pull apart.

When you install the "Dart" you are using the permanently efficient pipe coupling — which means no upkeep cost — no replacement cost — no loss from leaks.

There is a shape and size to fit every need. YOUR JOBBER SELLS THEM.

Manufactured by DART UNION CO., LIMITED, Toronto, Canada

There are many skeptical engineers who won't believe an advertisement, but who will accept the result of an actual demonstration.

We say to those men: "We don't ask you to believe us when we claim, month after month, that the **Dean Boiler Tube Cleaner** will remove scale from your tubes more **thoroughly** than any tool you have ever used.

"We simply ask you to let the **Dean** itself show you what it can do. Give it a trial at our expense. Then, if it doesn't live up to every claim we have made for it, ship it back and we lose."

To secure the details of our liberal trial offer, address any of the offices below. Ask for Booklet "Logic of the Dean."

The WILLIAM B. PIERCE COMPANY

153 Ellicott St., Buffalo, N.Y.

Western Representative :
W. W. HICKS,
567 Banning St., Winnipeg

201-2 Coristine Bldg., Montreal, P.Q.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have beeu approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways.

W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

Morehead
Back to Boiler
SYSTEM

60,000,000 Tons of Coal Thrown Away Yearly

Over 600,000,000 tons of coal are mined yearly in the United States and Canada. Ten per cent. of that enormous production is carelessly, needlessly wasted. Over Sixty Millions of Dollars are spent each year in producing—nothing, and yet, a mere fraction of that great loss, if properly applied, would save those wasted millions for years to come.

You are contributing to this national waste—but you can stop it.

Steam, after its expansive energy is exhausted, is not through with its job. There are heat units left—live, tangible heat units which were purchased by coal at the boiler's mouth.

What Are You Doing With These Heat Units?

This condensation, in other words.

With the Morehead System installed on your steam lines the condensation is automatically returned to the boiler—without pumps—and at any temperature. It is the last link from boiler back to boiler—the unused energy is not wasted.

If you would save this ten per cent. and have a clear steam system which drains automatically, write to-day for particulars.

CANADIAN MOREHEAD MFG. CO.
WOODSTOCK, ONTARIO

(PATENTED)

"AMERICAN"
All Steel Split Pulleys

Better than cast iron because of much less belt slip.

Better than wood—they hold a belt as well and wear better, and are not a fire risk.

"American" Steel Pulleys, made by the American Pulley Company, are better than other steel pulleys, because they are stronger, better made and use less power because of less windage.

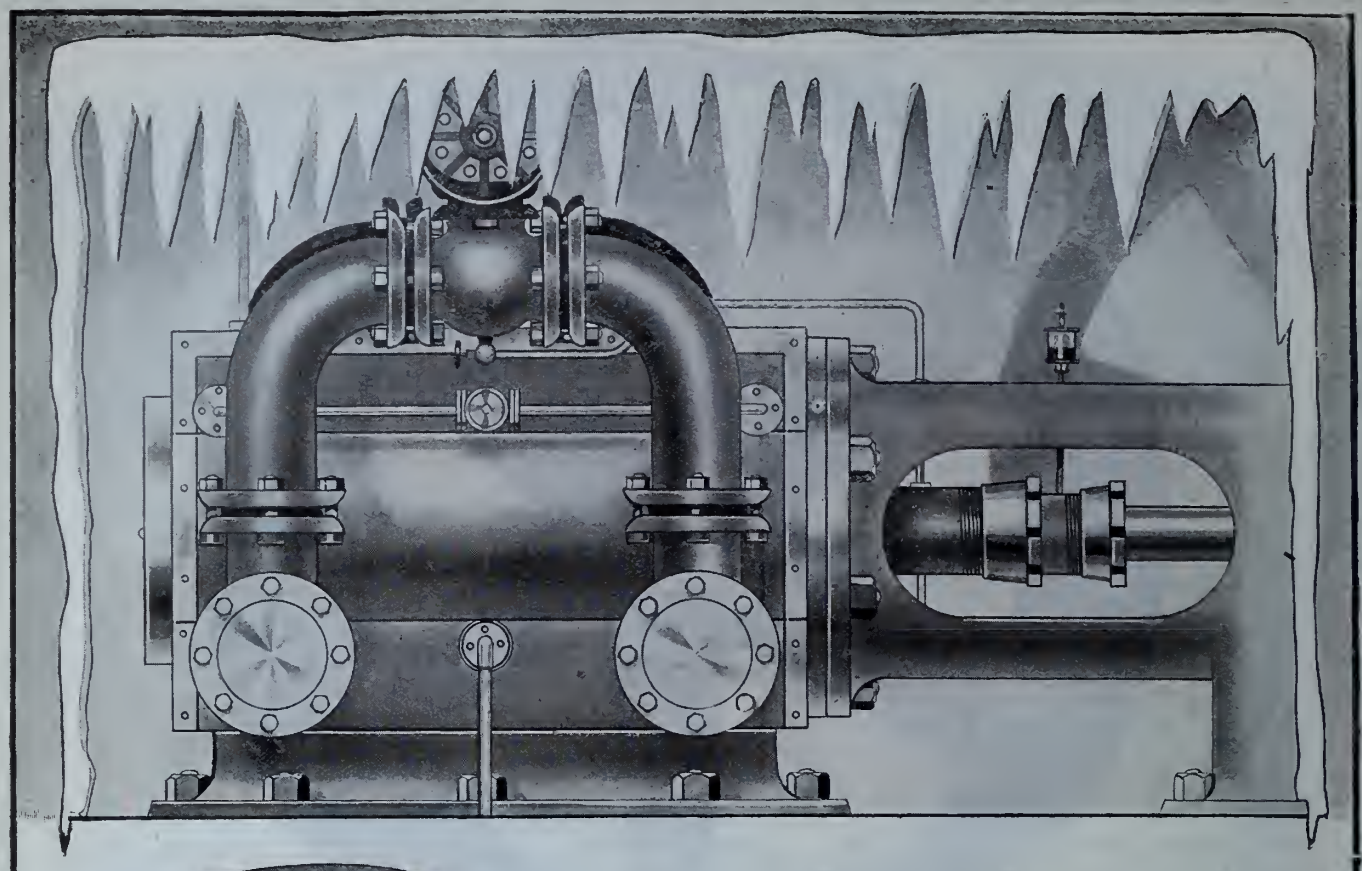
Stock sizes—3" to 72" in diameter
Larger diameters to specifications
Special pulleys for unusual duty
First All-Steel Belt Pulley made

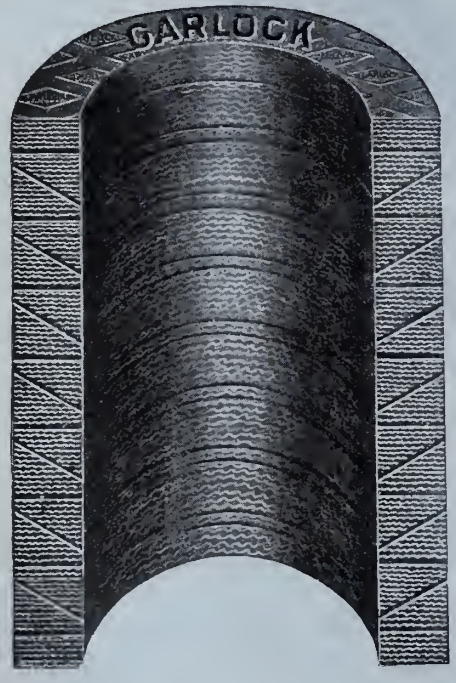
First in Volume of Sales
First in Efficiency
First in Esteem of Users
Interchangeable bushings

The American Pulley Company, 4234-60 Wissahickon Ave., Philadelphia, Pa., U.S.A.

Williams & Wilson, Limited, Montreal

The A. R. Williams Machinery Company, Limited, St. John, N.B., Toronto, Winnipeg. Vancouver





REFRIGERATING ENGINEERS

and owners of ice plants do not care to experiment with Ammonia Packing during their busy season. Conditions of temperature and lubrication demand a scientifically made, high-grade packing, for this service. Before repacking your compressor stuffing boxes this Spring, write to our nearest branch for catalog illustrating and describing several styles and combinations of

Garlock Ammonia Packings

or send us a statement of your conditions and requirements and benefit by our many years' experience in this field.

THE GARLOCK PACKING COMPANY, Hamilton, Ontario

BRANCHES :

Montreal, Quebec - - -	342 St. James Street
Toronto, Ontario - - -	404 Continental Life Building
Winnipeg, Manitoba - - - -	Galt Building

Mention this paper when writing advertisers. It will identify the proposition about which you require information.

THE BELT WITH A GRIP

"Lincona"

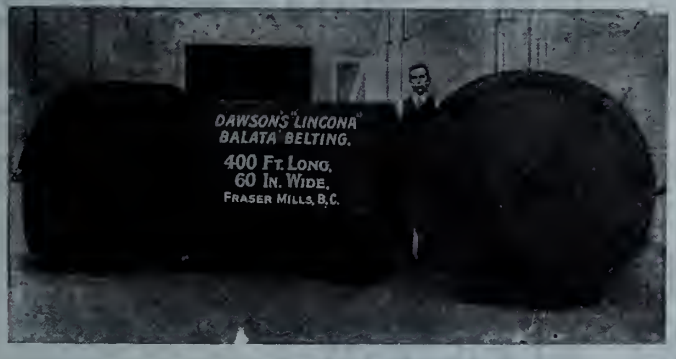
BALATA BELTING

will pick up a load suddenly better than any other type of belting

BECAUSE

it has a GRIP that no other belting has and requires no dressing.

"Lincona" will give you the maximum transmission of power



"Lincona" is the strongest Balata Belt Made.

The tensile strength of "Lincona" is almost double that of leather belting and there is less stretch and straighter running than any other type of belting.

The secret of the greater strength of "Lincona" Balata Belting is in making the Balata a fluid which will saturate the duck, instead of a paste placed on and rolled in. The fluid Balata used in the "LINCONA" process also allows the duck to be compressed more closely, so producing a Belt thinner for the number of plies. This gives a stronger wearing surface to the pulley and less friction.

"Lincona" Balata Belting can be exposed to snow, rain and every condition of weather without injury. It can be run in water without trouble. Write us about your specific needs.

Manufactured by

JAMES DAWSON & SONS, LIMITED, - LINCOLN, ENGLAND

The Canadian B. K. Morton Company, Limited

49 Common Street, Montreal **86 Richmond St. East, Toronto**

Austen Bros., Limited, Halifax, N. S. Sherwood & Fraser, Limited, Winnipeg, Man.
Western Oil & Supply Co., Vancouver, B.C.

TWENTY-ONE YEARS
ELEVEN YEARS WITHOUT LUBRICATION
AND GOOD FOR MANY YEARS MORE

GEORGE A. DIEMER, NEWBURGH, NEW YORK.

Magnolia Metal Company. July 22, 1916.

Gentlemen:

Referring to my letter of February 21st, 1911, advising you that sixteen years previously I had babbitted with Magnolia Metal a high-speed lathe — 3,500 R.P.M. — and countershaft hangers, and that they were still running in a No. 1 condition, and that a head shaft for motor drive had run much longer and had not received a drop of lubrication for the past six years.

I am pleased to advise you that this lathe and shafting are still running in the same easy way on the same Magnolia bearings, and that the only attention they have received since then, that I can recall, was last October, when I tested an invention to find the H.P. consumed. These bearings are still in fine condition, and will give many more years of good service.

Very truly yours,
GEORGE A. DIEMER.

PRACTICAL ENGINEER POCKET BOOK:

Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.

Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

OFFICE AND FACTORY:
225 St. Ambroise St. MONTREAL

UNEQUALLED WORKMANSHIP
HIGHEST EFFICIENCY
COMPLETE SATISFACTION

ESCHER WYSS & CO.

WATER-WHEELS
GOVERNORS
TURBO-PUMPS
STEAM-TURBINES

WRITE FOR INFORMATION AND PRICES

ESCHER WYSS & CO.
12 Coristine Bldg., Montreal

D. K. McLaren's

Genuine British-Oak Tanned

LEATHER BELTING

"Only flawless back leather is used and our genuine British Oak Tanning Process preserves every bit of the hide's natural strength.

Every inch of our belting is reliable, while our prices are the lowest—quality considered."

Grip that will give you more revolutions per minute

The use of this belting reduces slip to a minimum, thereby saving a considerable amount of power. It also saves a remarkable amount of time, labor and attention, because there is practically no stretch.

The toughness and durability of D. K. McLaren's belting makes lasting qualities that are suprising.

Many of Canada's largest industrial plants (firms that want the best of everything) are our steady customers.

Once tried, always used.

D·K·McLAREN LIMITED

Head Office and Factory: 351 St. James St., Montreal, P.Q.

TORONTO, ONT.	ST. JOHN, N.B.	VANCOUVER, B.C.
194 King St. West	64 Prince William St.	847 Beatty St.

This Quality Guarantee appears on every piece.

If any advertisement interests you, tear it out now and place with letters to be answered.

"MAPLE LEAF"

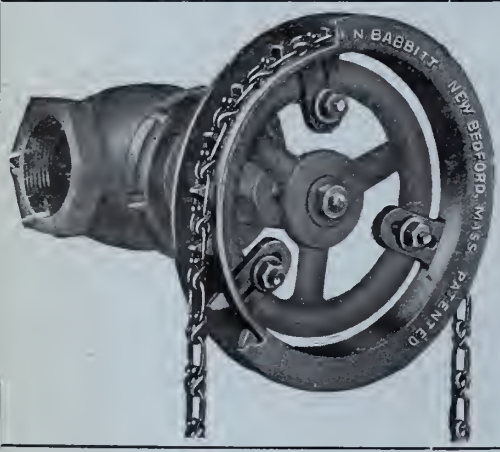
Stitched Cotton Duck
Belting

Excels all others in economy, strength, efficiency and true running, whether for Transmission of Power or Conveying.
A test recently made at McGill University, Montreal, of 6-ply "Maple Leaf" Belting, light double leather, and 6-ply rubber, showed that our "Maple Leaf" stood a breaking strain 50% greater than the leather, and 25% greater than the rubber belt.

A trial belt will convince you.
Write for prices and samples.

Maple Leaf Belt Dressing
The BEST for all kinds of belts

Dominion Belting Co., Limited
Hamilton, Canada



Goes Right on Your Present Valve Wheel

"Goes on" is about right, too, it's so easy to apply, and by putting a

Babbitt Adjustable Sprocket Rim

on each of those hard-to-get at overhead valves you can save a lot of time you now spend in hunting ladders and all the risk you now run in using them after you've found them. One concern that thought two would do, bought 27 in a little over two months. The price will encourage you to have enough of them.

Ask your dealer. Write for Illustrated Folder.

Babbitt Steam Specialty Co., 59 So. Water Street, **New Bedford, Mass.**
The R. E. Cleaton Co., 20 St. Nicholas St., Montreal, Que.

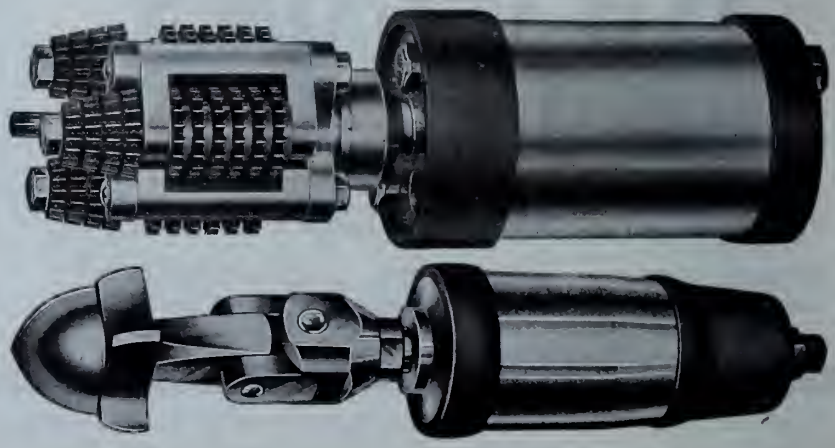
ROTO TUBE CLEANERS

Type A. D.—Driven by Air or Steam
Type W. D.—Driven by Water Pressure

More power from your boilers.
Less coal per power produced.
No burned out boiler tubes.

The only cleaners for hardest scale.
Safest and fastest for light scale.
Best for all boiler scale conditions.
Standard of the largest power plants.

THE ROTO COMPANY
Write for Catalog HARTFORD, CONN.



Which may we send FREE to YOU?

Send us the coupon to-day—now

How *could* there be a better way?

SILENT chain driving affords the combined advantages of belting and gearing without their disadvantages.

In simple terms, a silent chain drive to either machine, line or countershaft is—

(1) Positive in action (the same as is gearing).

(2) Flexible and elastic (the same as is belting).

(3) 98% to 99% efficient throughout its life (a saving of 2% to 20% in power, compared to gearing and belting).

(4) Quiet in action (but without the slip of belting).

(5) Not affected by heat, cold or moisture.

(6) Very reliable (no necessity for frequent tinkering and repairing, as with belting, nor frequent and copious lubrication, as with gearing).

Of the several makes of chains of the "silent type," the MORSE Chain is the one *different* chain—the exclusive "Rocker-Joint" construction setting it clearly apart from all other makes, and, as the service evidence seems to show, well above every other make in actual value (efficiency, durability and economy) to the user.

Each of the three bulletins illustrated opposite tells the complete story of the MORSE Silent "Rocker-Joint" Chain.

You may have one or all of them, without obligation of any kind, simply for the asking. Do it now.

Morse Chain Company
Ithaca, N. Y.

Sales Offices and Representatives in many important cities throughout the world.

MORSE CHAIN CO., ITHACA, N. Y., U. S. A.
Gentlemen: Please send me a free copy of your Pub. No.
A Chain of Evidence, as advertised in Power House
Company Name
Individual
Address
S—21

MORSE CHAIN COMPANY ITHACA, NEW YORK

If any advertisement interests you, tear it out now and place with letters to be answered.

Sliptivity
SteamCylinder

Sliptivity
Steam Engine

Automobile
Cylinder

OILS

These Lubricants give remarkable service. They will keep your machinery running smoothly, easily and with a minimum of wear and cost.

No better time than now to put them to the test. The prices are very reasonable.

Potato Scale Powder Boiler Cleanser

Will positively rid your boilers of old scale and will *keep* tubes clean if but a small amount is fed daily through the feed water.

Eliminates foaming, pitting or any other boiler troubles due to impurities in the water supply. *Makes big reduction in fuel bills.*

Sold UNDER A POSITIVE GUARANTEE. Try a Barrel.

C. C. SNOWDON

Oils Refiner, Manufacturer and Importer, Pennsylvania, Lubricating and Refined Oils, Gasoline, Potato Scale Powder, Liquid Soap, Disinfectants, Polish, Waste, Oil Tanks, etc.

Winnipeg—Cor. Notre Dame and Pine Sts., P.O. Box 1984.
Vancouver—823 Powell St.
Calgary—1S10-1840 Eleventh St. E., P.O. Box 1384; P.O. Drawer 166.
Edmonton—Cor. 13th Ave. and 83rd St., P.O. Box 877.

Good things for the POWER PLANT

If You Could Make a Safe Legitimate Investment of $100.00 Bring You Back $200.00 in a Year's Time, Would You Do It?

We would and we think *you* would. However, the mere doubliug, tripling or quadrupling of money doesn't begin to touch the possibilities from Cling-Surface.

As we recently showed you, Cling-Surface treatment of belting cau be the direct means for saving from $90.00 to several thousand dollars per year by reducing transmission friction in belted plants of from 50 to 1,000 h.p. Considering the very small expenditure for a few pounds of Cling-Surface and considering the large return, what better investment could you make?

An example: The 10-inch belt in the plant of the Aird-Don Co., Troy, N.Y., as shown in the picture, transmits 40 b.p. from a 14-foot to a 30-inch pulley on 30-foot centers. The engineer here, Mr. Louis J. Landmeir, tells us that scientific treatment of this belt with Cling-Surface costs him only 90 cents per year. Then he goes on to say:

"Belt has had Cling-Surface treatment about 3 years. Is very pliable. No trouble with lacings pulling out or with belt slipping. Never have to take up belt. Used various belt dressings, but never had such success as with Cling-Surface."

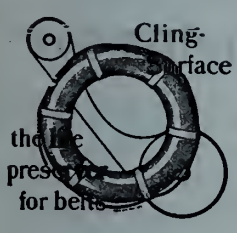
Cau you imagine how 90 cents could have been spent to better advantage?

Don't you think Cling-Surface worth investigating? Are your belts pliable? Do they run slack like the one in this picture? Do they pull maximum loads without slip? Are they waterproof? Durable? Troubleless?

They would be under Cling-Surface treatment.

Proof of all our claims awaits your inquiry.

We quote f.o.b. Toronto.



Cling-Surface Co

1057 Niagara Street
Buffalo NY

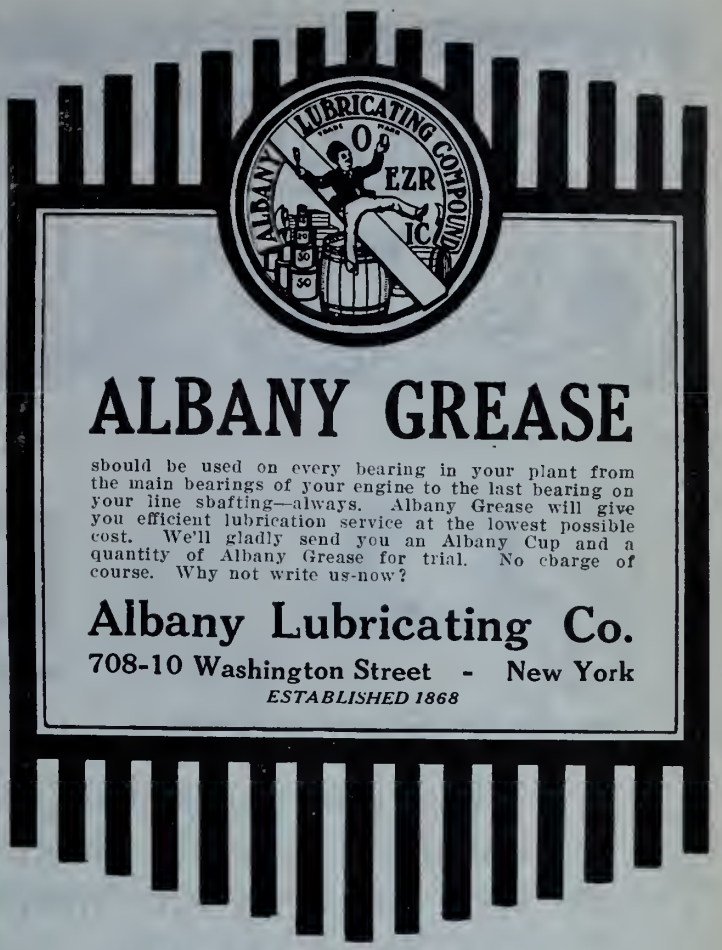
I am interested in Cling-Surface and your trial order proposition.

Name .....Position.....

Firm .....

Street .....

City .....Province.....



ALBANY GREASE

sbould be used on every bearing in your plant from the main bearings of your engine to the last bearing on your line sbafting—always. Albany Grease will give you efficient lubrication service at the lowest possible cost. We'll gladly send you an Albany Cup and a quantity of Albany Grease for trial. No cbarge of course. Why not write us-now?

Albany Lubricating Co.

708-10 Washington Street - New York

ESTABLISHED 1868

Detroit Lubricators

Have Given Satisfaction For Forty Years.

Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

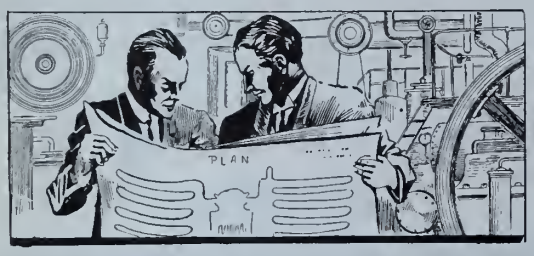
Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.

WALKERVILLE, ONT.



Do It Now

This month is the most opportune time to consider how the heat of the coming summer will affect your business. Prepare now. Let us advise and help you plan the most suitable Cooling Equipment for your particular use.

The Linde Canadian Refrigeration Co., Limited

37 St. Peter St., Montreal

Established and Manufacturing in Canada since 1896

Vilter Refrigerating and Ice-Making Equipment

is recognized as standard throughout the world. Our product is built in all sizes and capacities, suitable for every service to which refrigeration is applied. Write us for an estimate covering your requirements.

BULLETINS SENT ON REQUEST

THE VILTER MFG. COMPANY

242 Becher St. Milwaukee, Wis.

Mechanical Refrigeration

Saves Money—Increases Profits

By reducing your operating expenses and increasing your output, MECHANICAL REFRIGERATION paves the way to greater profits.

By improving the quality of your product, and keeping it up to standard it enables you to broaden your field and add new patrons.

But these results are possible only when the Refrigerating Equipment is correctly designed and properly installed.

We are constantly increasing our sales by reason of the excellent performance of existing YORK Plants.

We can serve you equally well. Write us for information and prices.

YORK MANUFACTURING COMPANY

(Ice Making and Refrigerating Machinery exclusively)

YORK, PA.

REPRESENTED IN THE DOMINION BY

CANADIAN ICE MACHINE COMPANY

MONTREAL, 626 Coristine Building. **TORONTO, 82 Chestnut Street.** **WINNIPEG, 85 Lombard Street.**

Uniform High Quality

Uniform high quality, which is so necessary in cold storage insulation, does not just happen. It results only from the careful selection of materials, scientific manufacturing methods and the rigid inspection of the finished product.

This shows sheets of Nonpareil Corkboard, 1, 2, 3, 4 and 6 inches thick, sawed through the middle. Notice the uniform structure in all thicknesses.

The uniform high quality of

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

is obtained by using only the best cork waste produced, the larger part of which comes from our own plants in America and abroad. All of the granulated cork is carefully screened to take out the fine particles, dust and other foreign matter, which decrease the strength of the corkboard. The baking is done in scientifically constructed ovens, thus ensuring uniform and thorough baking in all thicknesses. This is a most important operation since corkboard that is improperly baked will not stand up in service. The edges, ends and sides of every sheet are trimmed and sanded by machinery, making them uniform in size.

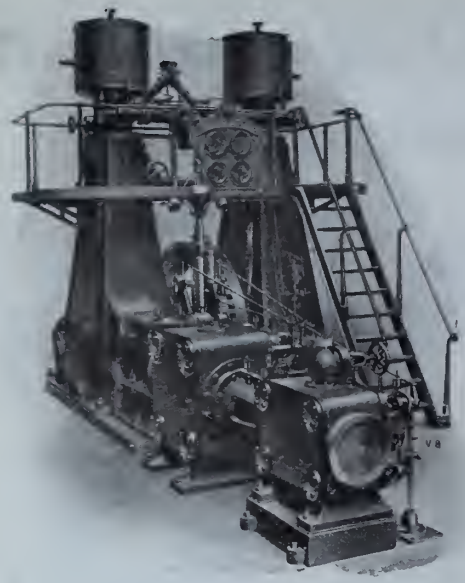
Finally, each finished board is inspected four times before it leaves the factory, thereby assuring the purchaser that his Nonpareil Corkboard will have the same uniform high quality that has earned for this material the title of "The World's Standard Cold Storage Insulation."

Literature and Samples on Request.

Armstrong Cork & Insulation Co., Limited 504 McGill Bldg. Montreal, Que.

Also manufacturers of Nonpareil Cork Covering for cold pipes and tanks; Nonpareil Insulating Brick for boiler settings; Nonpareil High Pressure Covering for steam lines; Nonpareil Cork Machinery Isolation for deadening noise of fans, motors and pumps; and Linotile for floors in offices and residences.

If any advertisement interests you, tear it out now and place with letters to be answered.



Why not operate your Plant with the highest efficiency and economy?

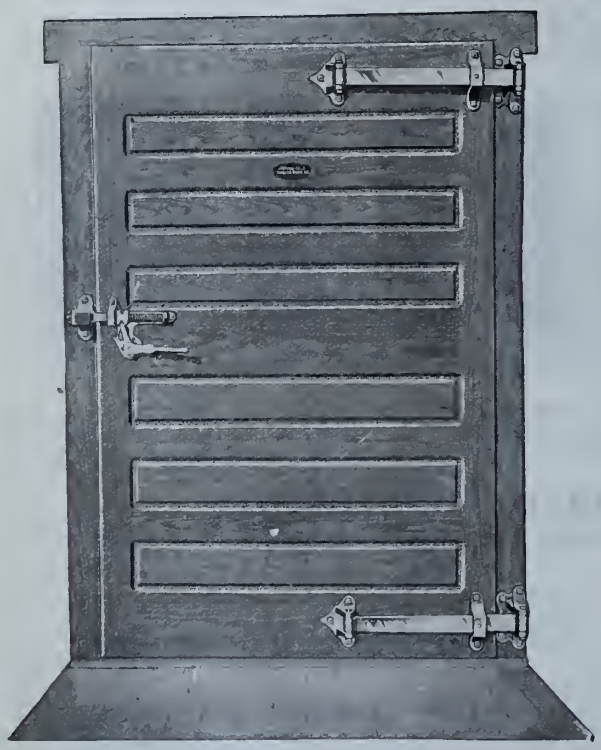
Write us advising what you have been doing and what additions you have contemplated.

Our Engineering corps will advise you impartially the best type of Plant for you to install and what you will need to reach the highest efficiency and lowest costs.

Get our new Fitting Catalog.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives:
THE FRICK ICE AND REFRIGERATION COMPANY, 357 St. Catherine Street West, Montreal



DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because:

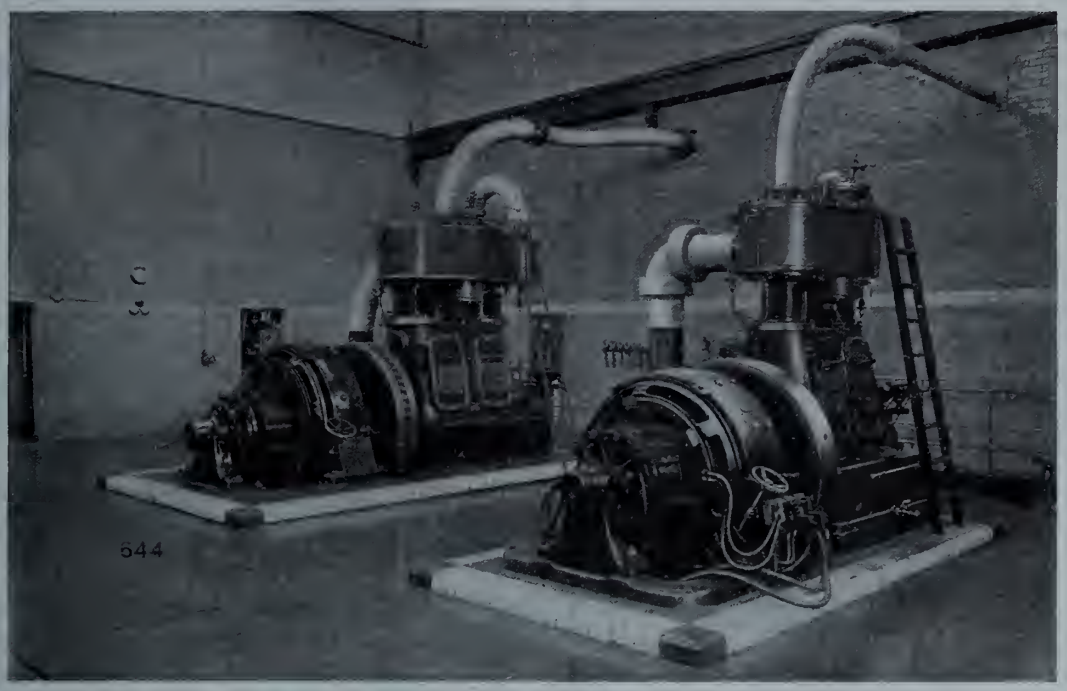
1st—Only the best materials are used in their construction.
2nd—We use heavier materials. Result: Longer life and increased efficiency.
3rd—Our doors are built with double and triple seals of contact—others have but one.
4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.
5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

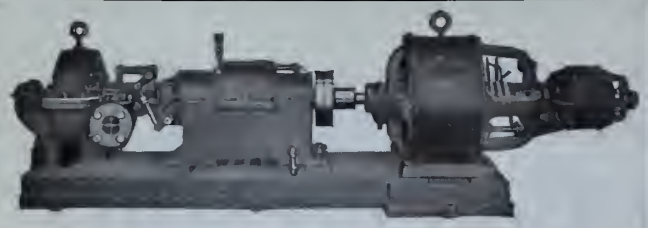
Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: **MONTREAL**



20 K.V.A. geared alternator for night lighting or isolated plant work.

Moderate Speed Alternators

THERE are many advantages in using moderate speeds for turbine-driven alternators, including simplicity, reliability and a construction that can be taken care of and repaired by ordinary operating men. Higher efficiency is also obtained in the turbine by allowing it to run at its best speed, which in certain sizes is far above the speed generally prescribed for the alternator by the frequency.

For this service we recommend the De Laval Double-helical Speed-reducing Gear, as shown in the accompanying illustration. The turbine can be suited for any steam conditions, as receiving steam at boiler pressure and exhausting against back pressure, to atmosphere, or to condenser, or running upon low pressure steam, or both low pressure and high pressure steam, or it can be modified to bleed steam for heating, drying or industrial purposes.

State requirements and ask for special Publication B61.

DE LAVAL

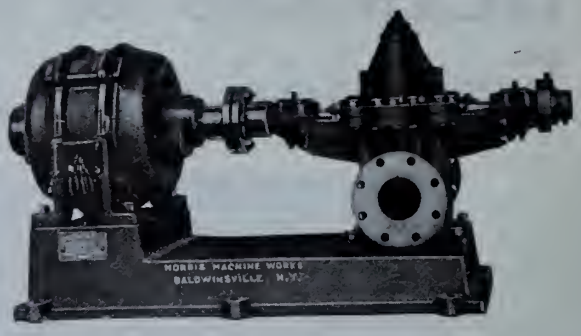
STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LIMITED,
Canadian Pacific Bldg., TORONTO, Canada.

THE E. LAURIE CO., 243 Bleury Street,
MONTREAL, Que.

253

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2″ to 20″ discharge.

Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.

Builders of Centrifugal Pumps, Hydraulic Dredges, Steam Engines

Canadian Sales Agents:

Storey Pump & Equipment Co., Toronto, Can.

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of paying for themselves in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps no adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

CANADIAN *Sirocco* COMPANY LIMITED

WINDSOR, ONTARIO.

SALES OFFICES:

Canadian Sirocco Co., 526 Traders Bank Bldg., Toronto. Phone Main 5118.
A. M. Nichol, McGill Bldg., Montreal.
S. S. Clarke, 605 W. Second St., Calgary.
W. W. Hicks, 567 Banning St., Winnipeg.
Canadian Sirocco Co., Ltd., 604 Credit Foncier Bldg., Vancouver.

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

CANADIAN AGENTS

A. R. Williams Machinery Co., Toronto.
Williams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American-Marsh Centrifugal Pump.

American Steam Pump Company

Battle Creek, Mich.

The Balanced Piston Valve

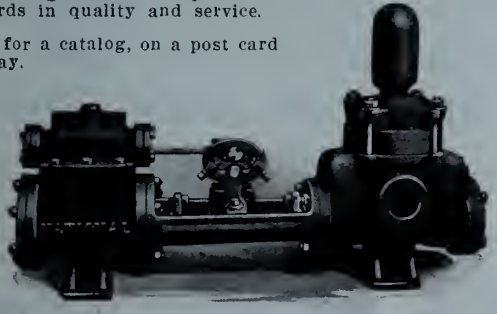
Simplifies the steam chest construction, elminates the slide valves, and gives better steam economy. The valve is fitted with snap rings to provide for wear.

NATIONAL STEAM PUMPS

National Pumps are made from the best materials under most careful construction, and embody the latest and best designs known to modern engineering.

THERE'S a National Pump to fill your every requirement and we guarantee every one to be the best the market affords in quality and service.

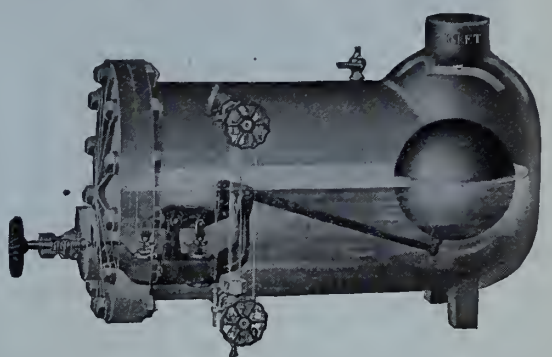
Ask for a catalog, on a post card to-day.



"NATIONAL" Boiler Feed Pump

National Steam Pump Co.

Upper Sandusky, Ohio



"I have about 25 Davis Traps of various sizes in service, the majority of them for 22 years. I will gladly recommend them at all times," wrote H. F. Hustedt, Chief Engineer, Tulane University, New Orleans, when ordering his first repairs.

Possibly all Davis Traps would not last that long without repairs. Much depends on the operating conditions. On some installations they last longer than on others. But all Davis Traps have Tobin Bronze seats and valves—a hard, tough metal from which long service may be expected.

And when these vital parts of the trap do wear out, they may be easily renewed at slight expense.

We make Pressure Regulators . Balanced Valve . Float Valve . Steam Trap . Back Pressure Valve . Exhaust Relief Valves . Stop and Check Valves . Pump Governors . Damper Regulators . Radiator Air Valves . Emergency Stop Valves.

G. M. Davis Regulator Co.

434 Milwaukee Avenue, Chicago., Ill.

New York, 123 Liberty—Boston, 70 High—Philadelphia, 260 N. 11th—The Renshaw Bldg., in Pittsburgh—Calvert in Baltimore, and Rialto in San Francisco.

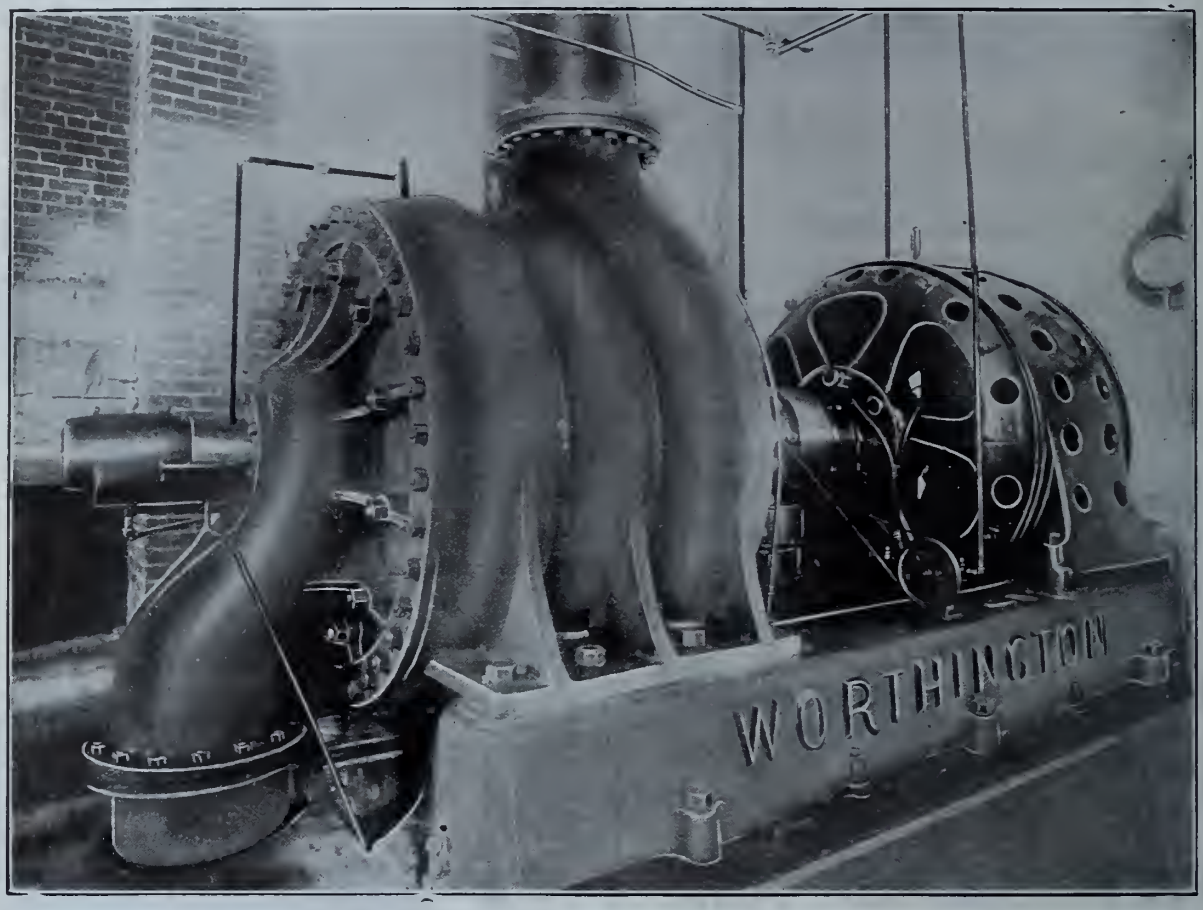
Valve Specialty Manufacturers Since 1875

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works: Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO February, 1917

A High Example of Faith in Advertising

WE are quite accustomed to the idea that advertising is more highly developed in the United States than elsewhere. We are prone to assure ourselves that American business have a stronger faith in advertising, a clearer understanding of its powers, and a higher efficiency in its use than is possessed abroad. We have been told so, often enough, by advertising men from other countries, so our belief is not attributable soley to egotism. Since the war began, however, England has been setting some examples of advertising which are not easily duplicated.

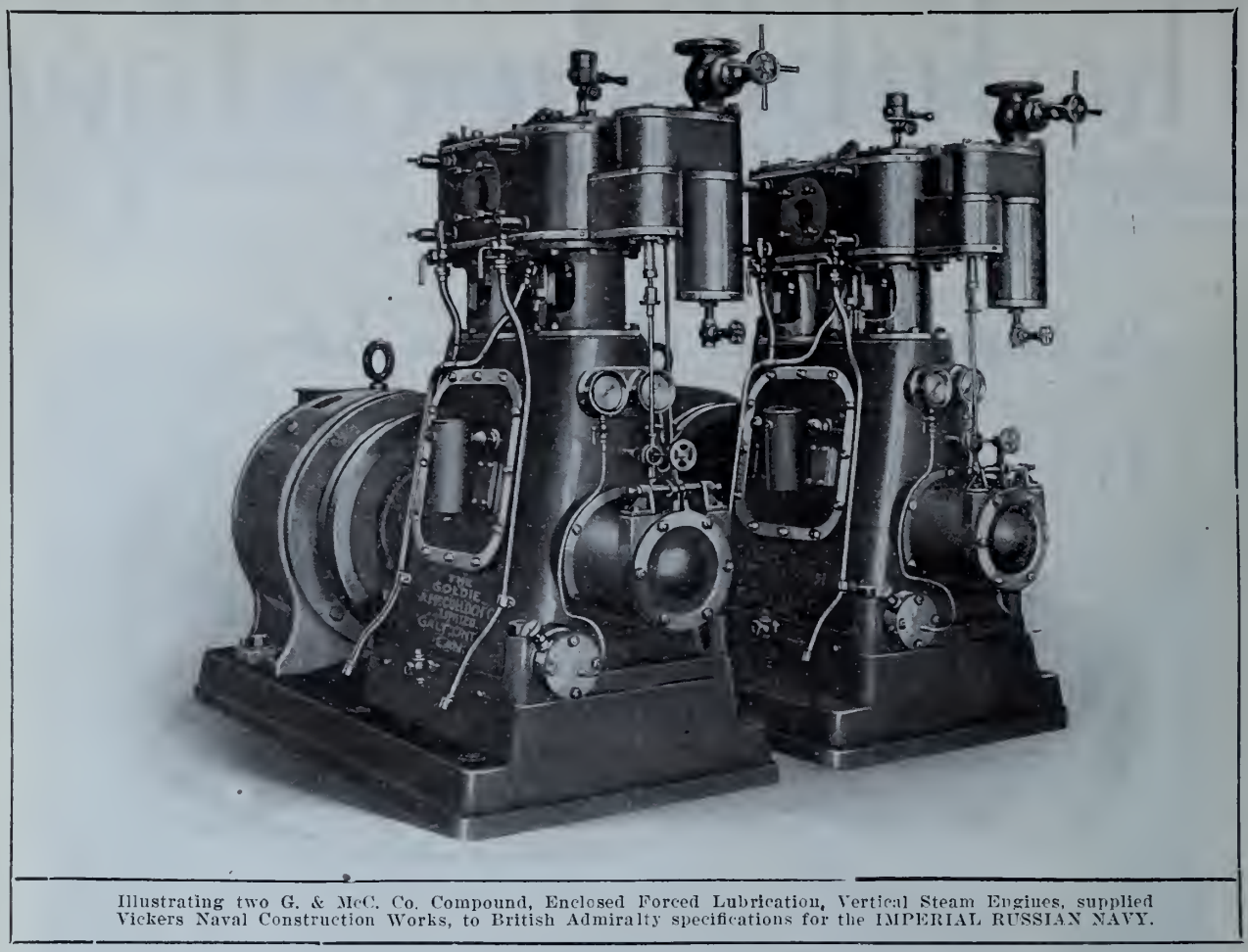
We have referred many times to the British Government's advertising for soldiers and for subscriptions to the war loans—an unprecedented and extremely profitable use of advertising on a tremendous scale. We have noted many instances of British concerns which have made far-sighted investments in advertising to protect their good-will under adverse circumstances. And now comes the British automobile industry with an example of faith in advertising which puts to the blush some of our American advertisers who are "oversold"—and cancel their advertising orders in consequence.

If it takes a high degree of faith in advertising to advertise when the factory is oversold, what about the faith which continues to advertise when it is practically impossible to sell any goods at all? That is just about the condition of the British automobile industry. In the first place, every available automobile factory which is not making cars for the army is making war munitions. There is an embargo upon the importation of pleasure cars from other countries. Private owners of automobiles are under an allowance of six gallons of gasoline per month. Sir Hedley Le Bas, the official advertising manager for the Government, is placarding the country with such warnings as: "You are helping the Germans when you use a motor car for pleasure." According to a special investigation sent by *Automobile Topics,* the retail trade is absolutely paralyzed. It is not only impossible to get cars, but to sell those cars which are already on hand. Yet, in spite of such discouraging circumstances, the British newspapers and magazines continue to carry automobile advertising.

The investigator above referred to specifically mentions Willys-Overland, Limited, Daimler and Wolseley as advertising for "after-war" business. Dunlop and Michelin tires are featured almost as prominently as ever. "The day is steadily drawing nearer when we shall resume the production of motor carriages for private owners," says a piece of Daimler copy, and when that day comes the company expects to occupy the same high place in the public mind which it had before the war began. It is using advertising as the best possible insurance against public forgetfulness.

The British automobile industry is setting a high standard of faith in advertising, and understanding of its true functions. American advertisers cannot afford to be too complacent over their "leadership" in the face of such examples as these—*Printers' Ink.*

THE POWER HOUSE
143-153 University Avenue - Toronto



Illustrating two G. & McC. Co. Compound, Enclosed Forced Lubrication, Vertical Steam Engines, supplied Vickers Naval Construction Works, to British Admiralty specifications for the IMPERIAL RUSSIAN NAVY.

POWER EQUIPMENT

that is built to British Admiralty Specifications is capable of producing that much to be desired

CONTINUOUS SERVICE

INSTAL YOUR OWN POWER PLANT, GET THE BEST ENGINES AND BOILERS OBTAINABLE. YOU WILL BE MONEY IN POCKET AND FREE FROM THE WORRIES RESULTING FROM FREQUENT INTERRUPTIONS.

The advice of our Engineering Department, Our Catalogues, Plans, Specifications, etc., are yours for the asking.

The GOLDIE & McCULLOCH COMPANY, Limited

HEAD OFFICE AND WORKS:
GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2 Traders Bank Bldg.
WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.
BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.
QUEBEC AGENTS: Ross & Greig, 412 St James St., Montreal, Que.

MAIN BUILDING OF THE UNIVERSITY OF TORONTO, NORTH OF AND FACING THE CAMPUS.

Engineering Laboratories of the University of Toronto

By Robert W. Angus, B.A. Sc.*

The growing recognition of the part played by technical education in national development imparts more than passing interest to the instruction plant by means of which the rising and future generations of this country's engineers are receiving knowledge. A study of the equipment described herewith, should convince even the casual critic that the requirements of engineering education have been recognized and met in a capable manner with a full breadth of vision, a desirable consummation in view of future world trade developments.

THE first engineering laboratory in Toronto was formally opened on February 24th, 1892, in the School of Practical Science, which is now the Engineering Building of the Faculty of Applied Science and Engineering of the University of Toronto. This laboratory consisted of three departments: First, the department for testing materials of construction. Second, the department for investigating the principles governing the application of power, which department included the steam laboratory, the hydraulic laboratory and the electrical laboratory. The third department was an astronomical and geodetic laboratory.

In the steam power department there were two boilers, the larger of 50 h.p capacity, a 50 h.p. Brown engine with condensers and pumps, and a machine for measuring journal friction and for testing lubricants.

The hydraulic division contained a three-throw pump driven from the Brown engine, a large impulse wheel, and two large tanks for orifice and weir experiments.

Initial Equipment

This equipment served very well at the beginning; there were not many students and thus a large number of pieces of apparatus was not necessary, and the apparatus actually installed was so well selected and suited the purpose so well that much valuable instruction was given on the machines mentioned.

As the work expanded and the number of students increased, small additions were made, but up to the time the writer was appointed demonstrator in this work in 1898, the only additions were two reaction turbines, neither of which was set up for operation, and a crude type of centrifugal pump, together with tanks for calibrating the orifices and weirs already mentioned.

During the past decade great advances have been made in the development of power, more especially in Canada, where we have been appreciating to some extent the value of our water powers. The gas engine has also been brought to a high state of perfection and suction gas has presented such great possibilities as to make it an important source of power.

Further, the work of the Engineering Faculty has been recognized by the people of the province in such a way that the attendance has increased by leaps and bounds.

For these and other reasons it has been necessary to increase steadily the equipment of the power department to illustrate the modern methods and also to provide sufficient apparatus for the increased number of students.

As the number of pieces of apparatus increased the available space became more and more crowded until during the last few years it has been difficult to carry on the work successfully. The steam laboratory had been placed in a comparatively low basement and the moisture and heat produced by the steam made the working conditions very bad.

After careful examination of the whole question, the Board of Governors of the University decided in June, 1908, upon the erection of a new building to accommodate the laboratories for steam, gas and hydraulic work and also for all general mechanical engineering, and the building described in this article is the result.

The money appropriated for the building as erected was between $85,000 and $90,000 and for new equipment approximately $22,000, although most of the apparatus which had been installed in the old laboratory has been moved in, so that the total value of apparatus and equipment in the new building would considerably exceed the $22,000 mentioned above.

New Laboratory

The building about to be described contains the laboratory for steam and gas engines, steam boilers, refrigerating machinery, belt and oil testing, and other similar work, and also that for hydraulic work of various kinds. It is built of white brick with white stone trimmings.

*Professor of Mechanical Engineering.

and consists of two parts divided by a wall running east and west, the part to the south of this wall having but one floor, while the part to the north has three floors.

When the building was first under consideration a number of very difficult problems presented themselves, partly in the way of finding sufficient room in already overcrowded grounds, and partly in the way of making the building harmonize with the other University buildings. In order to carry on the instruction required, a boiler room was necessary, which had to be placed on the outside of the building in order to facilitate the delivery of coal and the removal of ashes. Then, too, there was the problem of stacks, two of which have been provided for experimental purposes and the necessity of good light and large rooms, so that it was difficult to make the building look attractive. The architects considered the question with great care and arranged a scheme by which the boiler room and other unattractive parts will be eventually hidden when the entire group of buildings for the Faculty of Applied Science is completed.

The view on this page shows the building as it will finally appear. The front will be to the west and it will face on the main University road which runs north from College St., directly opposite University College. To the north of the building it is proposed in future to run a cross road east from the one above mentioned, the new road separating the Mechanical Laboratories and the building which will in time replace the present Engineering Building. At present there is only a very narrow passage between the two buildings. On the south the building will be connected to the future extensions to the Chemistry and Mining Building, which extensions are to be so planned that almost the entire south side together with the boiler room, which is now exposed, will be hidden.

The building will thus have a fine appearance and will with the Chemistry and Mining Building form a fine, large block quite in keeping with the nature of the work being done by this Faculty of the University.

Owing to the other pressing needs it was felt by the Board of Governors that it would be impossible to erect the entire building at the present time and as laboratory accommodation had to be provided the part containing this was erected and a reasonable number of class rooms provided in it, while the front part, which will contain more rooms of this nature, has had to be omitted for the present.

THERMODYNAMIC LABORATORY—SUCTION GAS PRODUCER PLANT.

The Thermodynamic Laboratory

Beginning with the space devoted to the heat engines and general mechanical work, we enter the Thermodynamic Laboratory. This laboratory occupies with the boiler room, the whole south half of the building and exclusive of the latter is 156 feet long by 60 feet wide with roof light throughout, there being no windows in any of the walls. It is divided into two parts, one being 40 ft. wide and the other 20 ft. wide, running the entire length of the room. The wider part has a clear height of 23 feet at the sides, being considerably higher in the centre. The narrower part has a clear height of 12 feet, and is divided up into smaller parts, there being eight small rooms, to be described later, and a space for delivery and unpacking of goods. The light is obtained from the roof and is as near perfect as can be expected. The ventilation is also very good being obtained by opening windows in the roof, a method which works so well that the building can be kept quite cool even with all the machines operating at once.

Internal Combustion Engines.—The equipment in the two parts of this laboratory may now be described in some detail, beginning with that in the larger part. The west end of this has been devoted to gas, oil, and other internal combustion engines and the equipment consists of a 10 h.p. engine built by Fielding

NEW LABORATORY OF FACULTY OF APPLIED SCIENCE CONTAINING STEAM, GAS AND HYDRAULIC EQUIPMENT.

& Platt, of Gloucester, England. This engine has a cylinder 7 in. in diameter and 14 in. stroke and has been specially built for experimental work. It is designed for variable compression, so that it may be adapted for use with different classes of fuels; and it is further equipped with three types of igniting gear, viz.: hot tube, high tension electric and a magneto gear, an arrangement being made so that the point of ignition may be varied at will while the machine is running. There is also a convenient method of varying the speed, and the use of heavy fly-wheels prevents great speed fluctuations at different speeds and loads. The engine is also fitted with vaporizing apparatus so that it may be run with oil, and has properly designed valves for the use of suction gas.

THERMODYNAMIC LABORATORY—GENERAL VIEW FROM WEST END.

Adjacent to this engine is a larger one built by the National Gas Engine Co., Ashton-under-Lyne, England. It has a cylinder diameter of 9 in. and runs at a normal speed of 200 revolutions per minute, giving 22 h.p. on city gas. This machine is a very fine sample of a gas engine, being exceptionally heavy and having two massive fly-wheels which give steady speed. It has variable compression as in the case of the Fielding & Platt engine, and is designed for the use of either city or suction gas. It has only the magneto form of igniter, but the point of ignition may be altered without stopping the engine, which is noiseless in operation.

As already explained, both the above engines may be operated by city or suction producer gas. In the former case the gas is drawn directly through a meter where it is measured. When the suction gas is used the latter is drawn from a producer in the small room in the south-west corner of the building. This producer, which was built by the Canada Foundry Co., of Toronto, consists of a generator complete with vaporizer, two scrubbers, and an expansion box from which the gas is delivered to a pipe conveying it directly to the engine. It is arranged so that fuel consumption tests may be made with it and the action of the producer carefully and accurately studied.

Adjacent to the Fielding & Platt engine and on the north side of it a test floor has been arranged so that engines of fairly large size may be conveniently tested, and it is hoped that various firms will, from time to time, place some of their engines at the disposal of the laboratory for examination and research work, as it is believed that this will prove of mutual benefit to the manufacturer and the University. This test floor is at present occupied by one of the earliest types of gas engines built by the Otto Gas Engine Co., Philadelphia. The engine has given good service in the engineering building for nearly twenty years and is retained to give some idea of the development of the gas engine of late years and because of its historical interest. It is one of the slide valve type of engines with the old form of gas flame igniter, and is in good condition for test and comparison with the newer machines.

The space immediately in front of the engines just mentioned is used for two smaller test floors for gasoline and other similar small engines. Each floor is three feet square and has adjustable slots by which any small engine may be accommodated.

A marine gasoline engine with a cylinder 6 in. diameter and 6 in. stroke has been given by the Canadian Fairbanks Co., Toronto, at a nominal price and has been placed on one of the test floors mentioned and set up for experiments. This engine is to be equipped with an optical indicator made by Dobbie, McInnes & Co., Glasgow, so that its action may be accurately studied.

On the south side of the large room is an Ericsson air engine which serves to illustrate the action of this type of engine and give figures on its economy. It is arranged to be run by city gas and a brake has been arranged to measure the brake horse-power at the same time as the indicator diagrams are taken. The efficiency of the machine as a pumping engine may also be found by allowing it to lift a measured quantity of water against a measured head.

Other Apparatus.—Proceeding farther east along the large room there is seen a fan on which experiments on its efficiency are to be made.

A little farther down is a slide valve model. This model is very complete, and has been constructed so as to give results on almost any design of simple slide valve or link motion. The length of connecting rod is adjustable, as well as the angle of advance and throw of all eccentrics, the length of eccentric rods, radius and point of support and suspension of the link, etc.

There is also a journal oil tester built by Riehle Bros. of Philadelphia, and having various adjustments. The journal used in the machine is a full-sized railway car journal, and the design is such

THERMODYNAMIC LABORATORY—DE LAVAL STEAM TURBINE WITH WILLANS VERTICAL AND LEONARD HORIZONTAL ENGINES IN BACKGROUND.

that the actual pressures and speeds occurring in practice may, within limits, be obtained. The friction of the journal is conveniently read off on a scale beam.

The Steam Engines.—We pass on now to the steam engines. The first of these are two of comparatively small size which were presented to the Laboratory by Messrs. E. Leonard & Sons, London, Ont. These engines are used almost exclusively for exercises in valve setting, and have cylinders 6 in. and 7 in. in diameter respectively, and 8 in. stroke, but have different types of slide valves. The one to the south has the ordinary D form of valve and a special design of eccentric may be independently varied. The other engine has a special type of inside admission valve, which is partially balanced and so designed that the engine may be operated without the steam chest cover and thus show the motion of the valves; this engine has an eccentric of the same type as the one just described.

THERMODYNAMIC LABORATORY—McEWEN AND LEONARD—BALL ENGINES WITH CONDENSING PLANT AT LEFT.

Both of these engines are fitted with throttling governors and suit the work for which they are designed exceptionally well, the kindness of the donors being much appreciated.

Next to these is a 15 h.p. de Laval steam turbine, built by Greenwood & Batley, Leeds, England. As is the case with most of the other machines, this turbine has been specially arranged for experimental work and has six nozzles altogether, some of which are for non-condensing operation and the others are used when running condensing. The rotor of this turbine runs at a speed of about 24,000 revolutions per minute, the power shaft running at one-tenth of this speed. This turbine has been found very useful as an experimental machine.

Behind the turbine is a Willans vertical, high-speed compound engine. This machine was purchased to drive the turbine pump in the old laboratory, but with the building of the new one an extra pump had to be installed so that a larger engine had to be purchased to supply the necessary power and the Willans engine became available for experimental work. It is of the high-speed type, having a normal speed of about 460 revolutions per minute, and developing at this speed 75 h.p. with a steam pressure of 125 pounds per square inch.

The design is rather peculiar, as there is no valve gear evident externally. The piston rods are hollow and the piston valves are operated by eccentrics forged solid to the crank pin. In this particular engine there are two high pressure and two low pressure cylinders, the high pressure cylinders being above the corresponding low pressure ones; all are single-acting, and in order to prevent shock on the crank at the end of the stroke there is an air piston below each pair of cylinders, the pressure of the air compressed by it being sufficient to make a continual downward thrust. The crank bearings have no upper cap and require none for the above reason.

The steam cylinders are respectively 10 in. diameter and 14 in. diameter, and all pistons have a stroke of 6 in.

Engines of this type have met with great favor in England because of the low steam consumption, a paper by Mr. Willians read before the Institution of Civil Engineers in April, 1893, giving some very valuable information along this line.

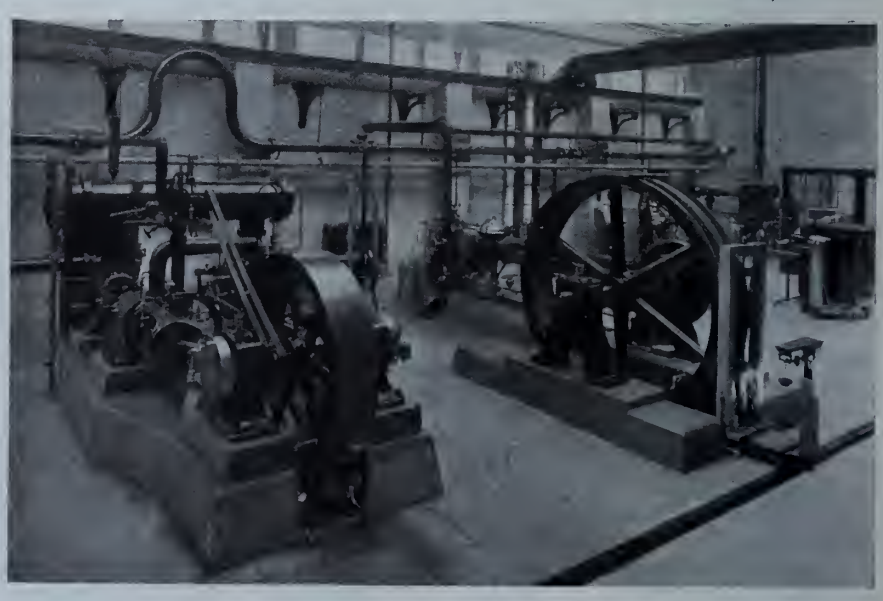
A passage leading to the door separates these engines from the McEwen high-speed horizontal engine. The cylinder is 8 in. diameter and 7 in. stroke, giving 18 h.p. This engine has a good form of shaft governor, so that it is well adapted to instruction in the use and action of such governors, as well as providing good indicator practice. As it is connected like the other machines to the surface condenser, tests on the economy of the machine may be conveniently made.

The Leonard-Ball tandem compound engine is also provided with a shaft governor of different type from the one mentioned above. This engine is horizontal and has cylinders 7 in. and 12 in. diameter by 10 in. stroke, and will thus develop about 29 h.p. at 250 revolutions per minute.

There are two types of valves in the engine, the one in the high-pressure cylinder being a Ball valve with double inside admission. The valve is partly balanced, gives rapid cut-off, and on account of the double parts has a comparatively small travel. In the low pressure cylinder a balanced D slide valve is used.

This engine provides instruction in the tandem type of machine as well as practice with a shaft governor.

Next to the engine just described is the air compressor, a machine built by the Canadian Rand Drill Co., Sherbrooke, Quebec, and purchased through Mr. Haight of the class of '96 at one-half the actual commercial selling price. This machine is of the cross-compound, steam-driven, two-stage type, having the low pressure air cylinder arranged tandem with and behind the low pressure steam cylinder, and the high pressure steam cylinder in front of the high pressure air cylinder. The steam cylinders are respectively 9 in. and 16 in. diameter, while the air cylinders are 9 in. and 14 in. diameter, all having the same stroke of 12 in.; the normal speed is 160 revolutions per minute and the rated capacity 340 cu. ft. of free air per minute,



THERMODYNAMIC LABORATORY—CANADIAN RAND AIR COMPRESSOR AND BROWN STEAM ENGINE.

with a steam pressure of 125 pds. per sq. in.

The fly-wheel is arranged with inside flanges so that a brake may be applied to it, and by disconnecting the air cylinlers the whole may be run as a cross

VIEW OF THERMODYNAMIC LABORATORY FROM EAST END.

compound steam engine. Both steam cylinders are provided with Meyer cut-off gear, giving considerable elasticity.

The low pressure air cylinder has Corliss inlet gear and pressure gauges and thermometers are arranged for experiments of various kinds.

An air receiver is installed and piping runs to the mining building, delivering air when required to drive a rock drill.

This machine is of great value and usefulness and forms a very good piece of experimental apparatus.

When the engineering building was opened it contained a 50 h.p. Brown automatic cut-off engine built by the Polson Iron Works, Toronto, and this engine has been set up again in the new laboratory. It is of special design for experimental work and has jackets on both heads and on the barrel, all jacket drains being separate in order that the condensation in each part may be independently determined. The clearance volumes in this particular machine are also made specially small, and it runs quite economically.

The Steam and Exhaust Piping.—An examination of the photographs will show the general arrangement of the steam piping. It consists of a single line of 5-in. pipe running through the boiler room and about 90 ft. along the wall of the Thermodynamic Laboratory, also of a 3½-in. pipe running from the northerly boiler up to the Brown engine connection. The latter pipe is designed so that it is possible to run a complete engine and boiler test on the Brown engine and the one 50 h.p. boiler. Connections are also made so that this boiler may deliver steam to the 5-in. pipe and the Brown engine may also be arranged to draw from the same pipe.

The 5-in. pipe has two large expansion bends, the one near the Brown engine being distinctly visible in the photographs. All connections on this line are flanged and each engine draws its supply from the top of the pipe, thus avoiding water from drainage and condensation.

All engines are arranged to run either condensing or non-condensing, two surface condensers with independent air pumps being installed for the former condition of operation. There are two 6 in. exhaust pipes, one of which is connected to the condensers, the other through the heater to the atmosphere. Both of these are arranged with flanged connections and the system is so designed that by the removal of a few bolts any engine may be changed from the atmospheric exhaust to the condenser in a very short time, it being only necessary to change one blank flange and turn an elbow through 180 deg. The operation is thus accomplished without the use of valves and the measurement of the condensed steam becomes at once accurate. The system also permits the running of almost any pair of engines condensing, and at the same time the operation of all the other engines non-condensing. Proper drainage is provided for all piping, and it has all given perfect satisfaction up to the present time.

The cooling water piping is shown below the steam piping, but possesses no special features.

Brakes.—The writer believes that brakes should be of the simplest form possible so that students get accustomed to the handling of the cheapest and most accessible types. The brakes used are, therefore, rope brakes or else simple forms of the Prony brake, the wheels being generally provided with inside flanges so as to avoid annoyance from the cooling water.

The remainder of the space in this part contains a test floor, which permits any engine submitted for test to be easily set up and run either condensing or non-condensing. There is also a space for the testing of injectors, these being arranged in a convenient and neat pipe stand ready for operation.

At the end of the room is a Cochrane feed water heater purchased from the Canada Foundry Co., Toronto.

Some space has been left at this end of the room for expansion, and it is hoped that in the near future a triple expansion engine will be installed here.

Small Laboratory Rooms.—The narrower southerly portion of the Thermodynamic Laboratory (with the exception of the two end bays, which are used for delivery and unpacking) is divided into eight small rooms for special work of various kinds. The first two rooms are connected by a door, and are used as a small repair and instrument-making shop, in which special apparatus is made as required. This shop contains a new 20-in. Bertram engine lathe of modern construction built by John Bertram & Sons, Dundas, Ont. There is also a 20-in. McDougall drill, an emery wheel and a wood-turning lathe, together with a good equipment of tools. The shop is driven by a Westinghouse motor.

The third room will contain the apparatus for testing various machine elements and the methods of power transmission. For this purpose a tor-

Thermodynamic Laboratory—Refrigerating Plant with Test Chamber for Building Materials on Left.

sion dynamometer has been purchased from J. Amsler-Laffon & Sohn, Schaffhausen, Switzerland, which may be used for the transmission of any power not requiring over 540 ft. pds. twisting moment. As the machine may be safely run

at high speeds its possibilities in the way of power transmission are fairly great, and it thus serves as a very flexible instrument. This instrument will be used to deliver a measured quantity of power to a belt or rope or any form of bearing or machine element, and the efficiency of the transmission or element may be directly determined by absorbing the power by a brake at the driven end.

HYDRAULIC LABORATORY—ESCHER, WYSS AND GWYNNE PUMPS DRIVEN BY BELLIS & MORCOM ENGINE.

The fourth room contains a refrigerating machine of three tons capacity, built by the York Manufacturing Co. of York, Pa. It is of the ammonia compression type and the horizontal steam engine and vertical compression machine are connected to the same crank. The complete accessory equipment has been provided and arrangements made for indicating the steam and ammonia cylinders and for taking the temperature at every desirable point in the plant.

The next room has been set apart for instruments, and in it are kept all of those used in both the Thermodynamic and Hydraulic Laboratories. All instruments are given out to students on application by ticket and are charged up against the one receiving them. When an instrument is returned it is examined and if in proper condition is put in its place, but if found to have been damaged by the student, the cost of repair is charged against him. By this system careless handling or loss of instruments is avoided.

The sixth room is used as a third year study room, while the seventh is to be used for the testing of lubricating oils and the determination of the heating power of gases and fuels of various types. A Sargeant gas calorimeter has been purchased and is to be used in this room.

The last room is occupied by the suction gas plant, described earlier in this article.

Just in front of these rooms and secured to the crane piers a number of tables have been placed, on which work on gauge and indicator calibration may be carried out, the gauge calibration being done by Crosby gauge testers, while the indicator springs are calibrated by means of steam supplied at various pressures.

The whole of the larger part of this laboratory is served by a three-ton travelling crane of about forty feet span. This crane is operated by hand, and has proved of inestimable value in the placing and handling of the different pieces of apparatus.

The Hydraulic Laboratory

The Hydraulic Laboratory occupies the north half of the building, and is located in the basement and ground floors, each of which is 40 ft. wide by 113 ft. long. The light for this laboratory had to be obtained from the north and east, and as only one large window could be placed in the east end, the north light had to be depended on almost entirely. Large windows running up the full height of the two laboratory storeys were designed, which take up three-quarters of the entire side of the building. This gives a good architectural effect, and while not giving as good light as is obtained from the roof in the Thermodynamic Laboratory, yet it is quite satisfactory.

On account of the large area of glass exposed to the north, trouble was anticipated in the way of heating the building, and arrangements were made to put double windows throughout, which, however, have not been necessary.

The lower storey or basement is 18 ft. high, and contains the well, the pumps and the engine for driving them, the measuring tanks used for calibrating the orifices and weirs above, several large troughs and the main part of the piping for the entire laboratory, while the upper floor, which is 15 ft. high, contains the orifice and weir tanks, the experimental centrifugal pump with its weir tank and motor, the various pipes for friction experiments, the meters, and also the various types of turbines and other apparatus.

Beginning with the top floor at the west end, part of the space had to be left clear for a hoist hole, the first piece of apparatus being a centrifugal pump of special construction for experimental work. This pump was designed along theoretical lines, and has carefully polished vanes on the runner; it is mounted on a weir tank so that the discharge may be very easily measured, the various heads under which it is operated being obtained by throttling. The pump is driven by a variable speed motor, by means of which the power put into the pump may be determined and its efficiency readily obtained. The arrangement has been found very satisfactory, as it gives the student an opportunity to study the effect of variations in speed, discharge, pressure and efficiency of the machine.

Adjacent to this are two orifice tanks and a weir tank used mainly for instruction in the use of orifices and weirs. Various sizes and shapes of orifices are inserted and operated under several heads as measured by hook gauge. The water is discharged through 6-in. pipes into the calibrating tanks below, of which there are six, two for each orifice and weir, each tank having a capacity of about 50 cu. ft.

These calibrating tanks are of some interest, and have been carefully designed so as to be entirely operated by the movement of a single lever. When the lever is put in one extreme position, one tank is made to fill, its outlet valve being closed, while the outlet valve of the other tank is at the same time open. For the small discharges the tank fills so slowly that the upper surface is quite smooth and undisturbed, and, therefore, the exact height of the water in the tank, and consequently the volume of the water at the moment of dumping is easily observed, but where the discharges are large, the surface of the water in the calibrating tank is so disturbed that accurate observations of this kind are im-

HYDRAULIC LABORATORY, FRANCIS HORIZONTAL TURBINE COUPLED UP TO 5 FT. 6 IN. STANDPIPE.

possible. To obviate this trouble the mechanism is so designed that by moving the lever to an intermediate position the outlet valve on the other tank is closed, and the discharge turned into it, the water surface in the first tank coming to rest at once its height is easily observed, after which the lever is pushed to the other extreme position, the outlet valve of the first tank being thus opened without disturbing the conditions in the second tank.

The quantity of water in the tank after filling may be found by direct weighing or by reading the level in an attached gauge glass.

The floor has been constructed with an opening protected by a rail, so that the student may observe the whole operation at one time and thus get a clear idea of the process of calibration.

In order that experiments on these tanks and orifices may be carried on without interfering with the other work, a large reservoir, provided with an overflow, has been placed above them, and from this they draw water. So long as there is enough water passing into the reservoir to cause some overflow the experiments may be carried on at various heads and discharges without difficulty.

From this reservoir a 1¼-inch pipe is also run to a hydraulic ram which can thus be operated under a head of about 10 ft. and with a drive pipe about 40 ft. long.

A three-inch Venturi meter has been installed on a pipe in which other meters will also be placed. This meter is rated by sending the discharge from it through one of the orifice tanks already described, using the coefficients determined by actual experiment.

A little to the east of the centre of the laboratory an elevated platform about 25 ft. long and 7 ft. wide has been erected for the impulse turbines. At present two turbines are in use, one a Doble wheel made by the John McDougall Caledonian Iron Works, Montreal. This is a very well finished wheel of 12 in. dia., and as it has glass sides the action of the water may be very conveniently studied. The needle regulating nozzle gives a very perfect stream.

The other machine is an 18-in. wheel made by the Pelton Water Wheel Co., and although not so well constructed, it represents a very common class of water-wheels in use to-day.

The water used by these turbines is measured by passing it through a weir tank and then back to the pump well. For the use of these turbines it is possible to get a discharge of 1 cu. ft. per sec. against a maximum head of about 500 ft.

At the east end of the room is a large stand-pipe 32 ft. high and 5½ ft. dia., supported on a stand in the basement so that it reaches up into the roof of the building. This stand-pipe is used as a reservoir for the reaction turbines and also for any experiments requiring constant but not very high heads. This stand-pipe has a 14-in. nozzle on each side for the attachment of turbines and also a large nozzle 30 in. dia. on the front so arranged that orifice plates and tubes of various sizes may be attached and experiments made at higher heads than is possible in the open orifice tank. The water is delivered to the stand-pipe through two 8-in. pipes near the bottom and by a convenient arrangement of baffle plates there is no trouble caused by the surging or eddying of the water.

In front of this stand-pipe is a large weir tank 20 ft. long by 6 ft. wide, which is arranged with a sharp crested weir 4½ ft. wide with end contractions. This plate may, however, be changed so that weirs of different sizes, with or without end contractions, may be easily inserted. The total depth of the tank is 3 ft. 9 in. and the depth of water below the crest of the weir is 2 ft. 3 in.

The weirs used in this tank may also be calibrated by means of a pair of measuring tanks in the basement, each holding approximately 240 cu. ft. and both being connected to the weir tank on the down stream side of the weir by 12-in. galvanized iron pipes. Hydraulically operated valves are to be used in connection with these calibrating tanks and are so designed that a single lever is made to do the whole operation of filling emptying as in the case of the smaller tanks already described. This lever, as in the former case, has three positions when operating, the extreme positions indicating that one tank is filling and the other emptying, while the intermediate position is used when both discharge valves from the tanks are closed and one of the tanks is filling. It is believed that very accurate co-efficients can be determined by this method.

There are three reaction turbines available for testing. The smallest one has a 6-in. runner and was made by Wm. Kennedy & Sons, Owen Sound, Ont. It has been set up in a steel penstock and connected to the stand-pipe by a 14-in. steel pipe containing two elbows. This pipe is to be used for experiments on the flow through elbows, the conditions being examined by a Pitot tube. This 6-in. turbine has been operated under a total head of over 25 ft. including about 5 ft. in the draft tube. The horse-power is measured by Prony brake and the discharge is determined from the 4½ ft. weir.

A 9-in. McCormick turbine with cylinder gate has not been set up but is left to give the student practice in the measurement of such wheels and to enable him to study the forms of the vanes.

The latest turbine to be installed is one purchased recently from the noted hydraulic firm of Escher, Wyss & Co., Zurich, Switzerland. This wheel, of the horizontal Francis type, has a well designed spiral casing and a runner nearly 14 in. dia. The gates are of standard design, operated through a ring by a hand wheel on the casing. A conical draft tube over 7 ft. long is used and the wheel will deliver 10 H.P. when supplied with 6 cu. ft. of water per sec. at a head of 20 ft. As this wheel is of the very best construction it forms an excellent addition to the experimental equipment.

BOILER ROOM—ONE 100 H.P. AND TWO 50 H.P. BABCOCK & WILCOX WATER TUBE BOILERS.

The maximum quantity of water available for these reaction wheels is about 6 cu. ft. per sec.

Along the north side of this floor near the windows arrangements are made for the testing of the friction in fire hose and iron pipe. A 2½ in. iron pipe 50 ft. long has been set up, also a 50 ft. length of fire hose, and the frictional losses are determined. The flow in the iron pipe is also studied by the Pitot tube, and curves showing the distribution of the velocity are plotted.

The basement contains, in addition to the orifice and weir calibrating tanks already mentioned, the well and pumping plant. All water used in the laboratory is drained back to a large well from which it is pumped into the system and used over and over again.

There are two sets of turbine pumps used for this purpose, one of which was built by Messrs. Gwynne, London, England, and the other by Escher, Wyss &

Co., Zurich. Each set consists of two two-stage pumps fastened to a common bed plate and driven by a single pulley, couplings being arranged so that either pump may be separately operated. Further, the two pumps on the one base are piped together in such a way that they may be made to deliver into the piping in three ways, viz., (a) separately, (b) in series, (c) in parallel. A connection is also designed to connect the discharge from the Gwynne pump to the suction from the Escher-Wyss pump, putting the two sets in series for very high pressure work.

Each of the Gwynne pumps will deliver 1 cu. ft. per sec. against 125 ft. head, while the other pumps have the same capacity against 150 ft. head, the discharge at lower heads being, of course, much greater.

As suitable piping has been arranged in the laboratory, it may thus be seen that the whole arrangement of the plant is very flexible, permitting (a) the operation of the four pumps separately, thus allowing four absolutely independent experiments at one time; (b) the operation of the two sets separately on separate experiments; (c) the operation of the two sets in series for high pressures and moderate discharges as are required in fire streams and impulse turbines, giving 1 cu. ft. per sec. at 500 ft. head; (d) the operation of the two sets in parallel giving about 6 cu. ft. per sec. at the heads available in reaction turbine work in the laboratory.

The pumps are of modern design, the Escher-Wyss set having been installed quite recently. They run at speeds of 1,300 and 1,400 revs. per min. respectively, and are belt-driven from a jack shaft placed on the floor, vibration of the building being thus entirely avoided. The jack shaft is driven by a Belliss Morcom engine of 130 H.P. running at 530 revs. per min. This engine is a very fine piece of workmanship and runs quietly and without vibration. The exhaust from the engine is used to heat the building.

Arrangements are being made for the insertion of a transmission dynamometer in the Escher-Wyss pump drive so that its efficiency may be determined with greater accuracy than can be obtained by indicating the engine.

A large trough 6 ft. wide, 4 ft. deep and 110 ft. long has been provided in the basement which is used for the rating of current meters and tubes and other work of this nature. It is believed that this will be especially useful in view of the rapid power development going on in Canada at the present time.

There is sufficient space still left for further expansion.

The Boiler Room

This room contains three Babcock and Wilcox boilers, all built for 200 lbs. pressure.

The 100 H.P. boiler is provided with a superheater while the two 50 H.P. boiler have been set up independently and one is arranged with a special type of setting so that valuable comparative results may be obtained.

A separate feed pump is provided for each boiler so that separate tests may be made on each one.

A steel breeching conducts the products of combustion to the stacks, of which there are two of brick, each 100 ft. high and 36 in. internal diameter. An arrangement of dampers allows these stacks to be operated at different powers on the same day and thus reliable experiments may be made on the capacity of each stack.

The room is light and airy, being 70 ft. long, 45 ft. wide and 26 ft. clear height. All the light is obtained from the roof and is very satisfactory indeed.

Offices and Study Rooms

AT the north-west corner of the building, immediately west of the Hydraulic Laboratory, there is a further space partly occupied by the stairways and halls and partly by other rooms. These rooms are as follows: In the basement the students' room with shower bath, on the first floor the professor's and the lecturers' rooms while the top floor is occupied by a lecture room and private lavatory.

An entire floor above the Hydraulic Laboratory is divided up into students' study rooms, a lecture room, a library, demonstrators' rooms, and students' lavatory. All of these rooms are comfortable and bright and the students' rooms are provided with convenient tables and a locked drawer for each person.

Artificial Lighting

The large Thermodynamic Laboratory is lighted by ten Nernst lamps, which are attached to the trusses and provide sufficiently good light to do any work required. The Hydraulic Laboratory is lighted by tungsten lamps, there being ten to each floor.

The remainder of the building, with the exception of the boiler room, which also has a Nernst lamp as well as incandescent lamps, is lighted entirely by incandescent lamps, which seem to give very good satisfaction so far.

Conclusion

This article would be incomplete without making mention of the work of Dean Galbraith. It was he who gave the writer his first real insight into the profession which he honors and it is on the foundation laid by him that the writer has built in striving to design a laboratory that shall give the future engineers the proper basic principles on which their life work depends. The teaching of principles is vastly more important than the teaching of a few facts, the desire to teach these principles in such a way as to make the practical application clear is a thing for which Dean Galbraith has always stood, and the writer's association with him and the engineering world have given him the desire to make the laboratories described such as shall be a real help to the student when he gets into active practice.

Acknowledgment is also made of the help given by the members of the staff in Thermodynamics and Hydraulics who assisted by many suggestions and by the sacrifice of much time in making the building and equipment such as it is.

It will be noticed that all of the units in the two laboratories are comparatively small and are such as can be handled with comparative ease. The writer believes this to be a valuable feature of such a laboratory, as the student can readily comprehend the whole machine at one time, and therefore does not lose the connection between the different observations as he is apt to do with the larger units where the parts are so much separated. The results obtained are, the writer believes, quite as valuable, from the point of view of the instruction to the student when obtained from reasonably small machines as from very large ones.

No machine in the laboratory is used for electric power or for any other than experimental purposes, so that all pieces of apparatus are always available for experiment or research.

OBTAINING DRAUGHT WITHOUT HIGH CHIMNEYS

IN ordinary practice, the use of the chimney is to cause a draught to make the fire burn, or in other words to cause the passage of a sufficient volume of air at a moderate velocity to supply oxygen enough to enable the fuel to be consumed to the greatest advantage, and incidentally to carry off the burnt (and unburnt) products arising through the combustion of the fuel. So far as it goes this is all right; but in very many cases it leaves much to be desired. To secure the most efficient heating it is necessary that the fuel should be reduced to its highest gaseous state—in the case of carbon this would in ordinary cases be carbonic acid—and to get to this stage it is necessary that large volumes of air must be drawn through the fuel at a comparatively low velocity. This is best done by means of exhaust fans of fairly large size, the discharge from which is passed through stacks of brushwood not too tightly packed together and kept damp by some simple method of water distribution and spraying.

A Moving Appeal.—"Yes," said the naive young person, "we invited three soldiers for dinner on Christmas Day. We felt we just had to, for mother said it was a crime to eat turkey at 42 cents a pound unless we had some sort of excuse for it. So we hunted one up quickly, and we never had such a delightful Christmas as we did entertaining three perfect strangers. What about them? Well, they stayed until nearly twelve o'clock, and I think they'd be here yet, smoking cigarettes, if one of them hadn't happened to be Scotch, and we suggested that they would have to be taking night cars very soon!"

Light, Heat, and Ventilation

HEATING AND VENTILATING RESIDENCES IN ENGLAND.

By C. T. Alfred Hanssen, A.M.I.C.E.

THE heating of a house, as pointed out, may be easily accomplished if ventilation be disregarded, and vice versa, the real trouble only beginning when an effort is made to combine heating with ventilation. The reason for the neglect and lack of development of heating systems in England is attributed to the peculiar weather conditions prevailing in the British Isles.

In most countries in Northern Europe and America the winter temperature is much lower than in England, and the cold is too deadly and dangerous to health to permit any neglect in the heating of houses, and there it is generally the ventilation that is neglected. In England, where the average temperature of the coldest month is well above freezing point, and where there has been no really cold winter during the last twenty years, it is the heating that is neglected and the ventilation that is encouraged. Although an immense amount of coal is used for heating our houses, it may be fairly stated that their average temperature is not much above that of the outside air, and although every inducement is offered to the air to enter our houses, by building them with open fire-places and large and leaky windows—often left open during the coldest weather—thin walls, and badly fitting doors, it is really a question whether our houses are, after all, much better ventilated than those on the Continent or in America.

Introducing Ventilation

Air, in common with all other substances, has that inertia which compels it to remain stationary unless it is acted upon by some force that causes it to move, and it is not, therefore, sufficient to provide openings for the air to enter; it is also necessary to provide some force to compel the air to move through the openings. If, for instance, there is a considerable difference between the temperature of the room and that of the outside air, every opening, however small, will have a current of air passing through it (and if the opening be large enough to examine it by means of a candle flame it can easily be seen that there is a lower current of cold air entering the warm room and an upper current of warm air leaving it.) A fire in an open grate will cause a column of warm air to rise through the chimney, and in this manner a large volume of air may be drawn through a room, but it is by no means certain that this air will ventilate the room. If the incoming air is colder than the air of the room it will probably sink down to the floor level, flow along the floor to the chimney, and pass out of the room without removing or displacing the vitiated air at the breathing level of the room.

Health Aspects

The difficulty of effective ventilation is therefore a double one: first, of causing the air to enter in such a way that it is not felt as a draught, and, secondly, of distributing the entering air over the whole room in such a manner that it really displaces the spent and vitiated air in the room. In bedrooms that are not, as a rule, heated, it is impossible to secure effective ventilation merely by opening a window, as the ventilation stops when the room is cooled down to the temperature of the outside air.

There is a widespread idea that cold air is healthy and that exposure to cold in chilly and draughty rooms hardens us and makes us better able to avoid the colds and catarrhs that are so frequent during cold weather. This, however, is one of these half-truths that are more dangerous than falsehoods. Vigorous exercise in the open air in places where the air is free from dust and smoke is undoubtedly most beneficial to health, and in this country there are very few days in the year when such exercise cannot be taken, but that is a very different thing from sitting or standing, almost motionless, in a cold room through which a current of cold air is passing. The air of our great cities is, especially during winter, very far from being of that purity which is most conducive to health, and even where it is admitted in a sufficient quantity and properly distributed through the whole room it is only a poor substitute for the air of the sea, field and forest. When, however, this air is admitted in such a manner that it forms only a cold current at the floor level, and is allowed to rush into a yawning chimney shaft a few feet above the floor, there cannot be the slightest doubt that ventilation of this kind is wholly injurious and deleterious to health.

Foreign Weather Conditions

Foreign cities generally show an increase in the death rate during winter, but the average temperature during each quarter has not been available to the author, and he has therefore only given examples from Paris and New York. In Paris open fires are used, but as people live in flats the houses are much more substantially built, and although the winter as a rule is somewhat colder than in London, the rise in the death rate is not so pronounced. In New York the winter is much colder than in London or Paris, but as the houses there are kept warm by stoves or radiators, the increase in the death rate is much less than in Paris or London. The conclusion, therefore, seems irresistible that although vitiated air undoubtedly is very bad for the health, cold air nevertheless is still worse, that during every cold wave in London as many people are killed as at the outbreak of an epidemic, and that is is a worthy object of sanitary engineers to persuade people to have their houses heated and ventilated in such a manner that the winter death rates should not be substantially higher than they are during the summer.

Ventilation.

Although the essential fact regarding the quantity of air required per person for effective ventilation is fairly well established, the quantity itself as stated by good authorities varies within very wide limits. Sir Napier Shaw, F.R.S., in Air Currents and Laws of Ventilation, demands as a normal unit 1 cubic foot per second per head, or 3,600 cubic feet per hour, while Molesworth's Pocket Book under "Ventilation" gives 300 cubic feet per hour for proper ventilation for a healthy man. The essential fact is that the atmosphere under normal conditions contains 4 parts of carbon dioxide per 10,000 parts of air, and that this proportion should not be unduly increased. The average quantity of air inhaled by an adult is about 16.6 cubic feet per hour, and the exhaled air contains 4.5 per cent. of carbon dioxide, or 450 parts per 10,000. The point in dispute is the quantity of CO_2 which may be allowed in the air of a room over and above the normal quantity of 4 parts per 10,000. If an excess of only 2 parts per 10,000 can be permitted then the quantity of fresh air required is $(16.6 \times \frac{450}{2} =)$ 3735 cubic feet per hour, but if, as others maintain, it is quite safe to go up to an excess of 25 parts per 10,000 then only $(16.6 \times \frac{450}{25} =)$ 300 cubic feet per hour are needed. The essential point in all systems of ventilation is that the incoming fresh air should be uniformly distrib- throughout the whole room, and

*From paper read before the Society of Engineers, London, England.

should, as far as possible, displace the vitiated air in the room, and for this purpose the incoming fresh air should have approximately the same temperature as the air in the room, as otherwise convection currents will cause it either to rise to the ceiling if it is warmer, or to fall to the floor level if it is colder than the rest of the air in the room. Under ordinary conditions the air exhaled from the lungs will by virtue of its higher temperature, rise towards the ceiling, although its high percentage of carbon dioxide makes it heavier than air of the same temperature. There is a critical point at about 80°F. when the exhaled air no longer rises but remains stationary at the breathing level of the room and, therefore, increases the difficulties of efficient ventilation.

The specific heat of air at constant pressure is 0.238 and one British thermal unit of heat will, therefore, raise $\left(\frac{1}{0.238}\right)$ 4.2 lb. of air 1°F. The volume of 1 lb. of air varies from 12.4 cubic feet at 32°F. to 13.1 cubic feet at 60°F. and at this latter temperature 1 B. T.U. will, therefore, heat about 55 cubic feet of air 1°F. The cost of heating a liberal supply of air to a moderate temperature is not, therefore, very heavy, and if suitable apparatus is provided for this purpose it is quite practicable to supply the full quantity of air demanded by Sir Napier Shaw at a very moderate cost.

Cost of Heating

The cost of heating the air can be estimated when we know the average temperature of the outside air, the proposed temperature of the house to be ventilated and the volume of air to be introduced into the house.

An average family consists of six persons and supposing them to require 3,600 cubic feet per head per hour, an average house should have a supply of 22,000 cubic feet of air per hour. To introduce this air into the house by means of open windows and open fires is not only a very clumsy method, but it is during the winter also a very expensive one. We may hope that one of the first results of national re-organization may be an abundant supply of cheap electric power and that this power may be obtainable at a rate of one penny per Board of Trade unit. A well designed fan with an efficient electric motor supplying the above quantity of air will then work 24 hours per day for about 1¼d. or 38s. per annum, and will save a great deal more than this value of coal.

Where the air supply is admitted to the room at a moderate temperature slightly cooler than the temperature of the room itself, and with an initial velocity of not more than two feet per second, the inlet openings should be of ample size, adjustable according to the number of persons present in the room and at the breathing level or about 4 ft. 6 in. above the floor. For ordinary rooms the outlet openings may be much smaller and as all impurities as a rule rise towards the ceiling, they should be there, and may conveniently be arranged as adjustable outlet-openings into the chimney-flue.

Heating.

The most convenient and most sanitary fuel for heating a house is undoubtedly gas, but in order to have gas heating as a practical possibility the cost of gas must be very materially reduced. One pound of coal yields about 14,000 B.T.U., and a ton of coal, therefore, yields 31,350,000 B.T.U., while calorific value of a cubic foot of gas may be at 535 B.T.U. A ton of coal is, therefore, equivalent to 58,700 c. ft. of gas and with gas at 3s. per 1,000 c. ft., this is equivalent to coal at £8 16s. 1d. per ton. Gas is, therefore, at present, far too expensive for continuous heating and can be used only for cooking and temporary heating of rooms used on special occasions.

If producer gas were added to the present supply, and the mixture used exclusively for heating, distributed more continuously under higher pressure, and with an increased velocity in the mains it would be possible to distribute it at such a price that it could compete with coal, say at 9d. or 1s. per 1,000 cubic feet of equivalent heat value. The benefit of this to the community would be enormous. There would be an entire elimination of smoke from the atmosphere and a consequent improvement in the sanitary condition of our towns and cities, the heating and ventilating arrangements would be under perfect and automatic control, and in every household the hard drudgery, done mostly by women, of carrying coal and ashes, lighting fires in the morning, and stoking them every hour of the day, would be entirely abolished, and at the same time all the valuable by-products, such as coal tar and sulphate of ammonia, which now poison the air we breathe, would be made available for industry and agriculture. The universal use of gas for heating and cooking is, therefore, one of the most pressing public needs.

We cannot hope to reduce the present quantity of fuel required for heating any given building to a certain temperature unless we first ascertain how the heat now used for this purpose is distributed. In testing the economy of engines and boilers, the great point is to give an exact account of the heat generated by the fuel, the heat utilized and the heat lost.

A large number of experiments have been made with domestic fires, but it does not appear that any heat balance sheet has been made, and although it is evident that great losses occur it is not clear from these experiments what becomes of the heat and why the heating effect is so small.

Some very careful and interesting experiments were carried out for The Coal Smoke Abatement Society by Mr. Alfred S. E. Ackermann, B.Sc. (England), A.M.I.C.E., and Dr. J. S. Owens, A.M.I.C.E. The best and most economical result was found with an open grate of the D.O. Boyd "Hygiastic" type which burned 3¾ lbs. of coal per hour when heating a room of about 4,000 cubic feet capacity. The total calorific value of the coal was 55,350 B.T.U., and this raised the temperature of the room to 59°F. when that of the outside air was 37°F., and that of the air entering the room from an adjoining passage was 41°F. A volume of 9,738 cubic feet of air per hour was drawn from the passage and went up the chimney with a velocity of 6.85 feet per sec., and at a temperature of 100°F. The heat used for warming this air during its passage through the room was 3,780 B.T.U., or 6.83 per cent. of the total heat evolved from the coal, and the heat used for heating the flue gases from 59°F. to 100°F. was 7,749 B.T.U., or 14.0 per cent. of the total heat. The remaining heat, 43,821 B.T.U., or 79.17 per cent. of the total, is given as radiated to the walls of the room, drying and heating them. It is evident that if the walls of a room were heated they would communicate their heat to the air of the room and that this would show itself by an increased temperature, and where this is not the case it is certain that the heat escapes through the walls and windows which are far more permeable to heat than is generally supposed.

Conductivity and Radiation.

The conductivity of a wall is for all moderate temperatures exactly proportional to the difference between the inside and outside temperatures and it is for brick walls approximately inversely proportional to the square root of the thickness of the wall.

To ascertain the radiation from an ordinary sitting-room, some approximate tests were made in a room with a floor area of 221 square feet and a height of 9 ft. 6 in., having a total capacity of 2,100 cubic feet. The room was heated with an "Artesse" anthracite stove burning day and night through the whole of last winter. The coal consumption varied from 16 lbs. to 25 lbs. for 24 hours, according to the temperature of the outside air. During the 16 hours per day, when the room was occupied, the temperature was kept as nearly as possible at 60°F., and during the night the fire was banked up with 4 to 5 lbs. of coal, the air supply was reduced and the temperature fell during the night to about 50°F.

During the coldest days of this year, when the outside temperature fell to 30°F., the coal-consumption during the day was about 1¼ lbs. of anthracite nuts per hour. Taking the thermal value of the coal at 15,000 B.T.U., the heat generated was 18,750 B.T.U. The windows were closed and the air supply for ventilation was taken from the corridor where the temperature was about 45°F., and through the leaks round the windows. The ventilation certainly did not come up to Sir Napier Shaw's standard and as nearly as could be estimated the change of air was 8,000 cubic feet per hour, and there were complaints of "stuffiness" when more than two persons occupied the room.

Heat Losses and Ill-Health.

The total quantity of anthracite coal used for the season was two tons, or an

average of about 20 lbs. per diem, and the efficiency of the stove was $\left(\frac{15{,}088\times100}{18{,}750}\right)=80.5\%$. The heat used for warming the air was only 14.5 per cent., all the rest of the heat being lost as far as this room was concerned, although the heat lost through the inside walls was useful as it raised the temperature of the corridor and adjoining rooms. Of the remaining heat 52.1 per cent. is dissipated into the outside air through the walls, floorboards and windows and the remaining 33.4 per cent. of the heat radiated into the room, escaped to the other parts of the house.

Dr. Owens' tests do not show the amount of heat radiated from an open fire either of coal or gas, and the author is not aware of any reliable radiation tests carried out with coal fires. With gas fires, however, a great many tests have been carried out by the two great London gas companies, and it seems certain that from an ordinary open gas-fire about 45 per cent. of the total heat of the gas will be radiated into the room, according to the latest bolometer tests.

The low percentage of heat radiated into a room from an open fire,—less than 20 per cent.—coupled with the high conductivity of the walls of an ordinary dwelling house, increases the cost of heating and also raises the death rate, and British tastes and habits must be successfully met by some apparatus capable of producing a pleasant and cheerful heat without wasting four-fifths of the heat uselessly.

Particular reference was made to the lack of proper heat insulation, compared with Continental and European practice, while mention was also made of a type of wood stove used in Petrograd, which while designed for wood, could be easily adapted for gas, were such fuel commercially available.

Insulation of Walls

The system of heat insulation to be adopted should be one that can be used for existing houses without any excessive expense. Slag-wool appears to the author to be almost an ideal substance for the purpose, as one inch of slag-wool is as good an insulator as a foot thickness of brickwork. It is, moreover, fire-proof, sound-proof, and vermin-proof, and is at the same time a fairly cheap material; the pre-war price was £4 10s. per ton, which contains 200 cubic feet, so that a layer 4½ inches thick would cover 530 square feet per ton and, therefore, cost about two pence per square foot of external wall surface, and if made in large quantities this price could, probably, be reduced. At the above price a suburban dwelling-house as described above could have the whole of its external walls, partition wall, ground floor and upper ceiling effectively insulated, equivalent to about 4 ft. 6 in. extra thickness of brickwork at a cost of about £35. For new houses the walls should be built with a hollow space filled with slag-wool during building. Slag-wool should also be placed between the joists of the floor and above the ceiling. For existing houses slabs of slag-wool may be attached to the inside of the walls. One in. slag-wool slabs will retain 60 per cent., two inches will retain at least 70 per cent., and four and half inches will retain over 80 per cent. of the heat now wasted.

As over 21.3 per cent. of the heat lost by conduction passes through the windows, it is of great importance that these should be more carefully fitted and that they should have double sashes.

A house fitted in this manner would not only be warm and comfortable in the winter, but also cool during the summer, for the same insulating material which prevents heat losses from within during the winter would prevent the entrance of heat from without during the summer. It would, further, be practically sound-proof and all the distressing noises, inseparable from great cities, and which so frequently disturb the rest of those that are unwell or indisposed, would be kept out of the house.

There would also be a great reduction in the domestic work, not only would the lighting and stoking of fires be abolished, but dust would be prevented from entering and a great deal less dusting, washing and house-cleaning would be required. If the heat losses are reduced 80 per cent., the fuel used for heating the whole house to a comfortable temperature would actually be less than the fuel now used for heating one or two rooms in the very imperfect manner it is done at present.

RECOVERY OF LUBRICATING OILS

LARGE quantities of oil are used in all machine installations, for lubricating purposes, and though the amount actually required to effect efficient lubricating is relatively small in each case, considerable excess is, for one reason or another, generally employed. For the sake of cleanliness, catch pans or grooves are provided to receive all oil working through bearings, so that the excess oil, mixed with dust and dirt, and usually "worn" to a more or less insignificant extent, is available for re-use, providing it be first cleansed. Machines for this purpose are to be had, but some of these require much attention in order to maintain satisfactory results, and cannot in any case be applied to thick cylinder oils and similar lubricants. The demand for a simple means of cleansing oils rapidly and economically is perhaps best met by centrifugal separators.

With more or less unimportant distinctions between individual makes, these machines comprise a conical whirling receptacle keyed on to a shaft and rotated at high speed within a stationary cast-iron drum. Oil to be cleansed is placed in a container within the whirling frame, and the latter is set in motion. Centrifugal force drives the oil up the smooth walls of the container to the rim, and hurls it thence through a fine brass gauze screen, which removes light foreign material carried up with the oil; heavy impurities remain at the bottom of the rotating vessel. In large installations it is preferable to employ separate machines to remove heavy particles from oil, and to clarify the latter completely. Purified oil may be conveniently compared with new oil by smearing a drop of each side by side on a sheet of clean paper. When the latter is held to the light, any suspended particles of muddiness in the separated oil will be easily detected.

BOILER INSPECTION AT MONTREAL

ALTHOUGH his annual report is a year behind, boiler inspector E. O. Champagne is once more able to inform the public that for the year 1915, no boiler explosions occurred in Montreal. This long immunity from serious boiler accidents has been a feature of Mr. Champagne's reports for many years, and in that connection a letter of congratulations is quoted from the Travellers' Indemnity Company of Hartford. The following is the record for steam boiler inspection for 1915:

Visits of inspection	3,112
Internal and external examinations	1,889
Hydraulic tests	1,621
Hydrostatic tests	606
Imperfect boilers	203
Boilers condemned	4
New and second-hand boilers erected	77
New boilers (included in this number)	65
Notices of inspection issued and received	922

The licenses issued to engineers and others after due examination to take charge of steam boilers was 2,255. Those who failed to pass examinations numbered 127.

Visits made in connection with new devices for smoke abatement were 767

CUBAN DEMAND FOR GASOLINE MOTORS

UNITED STATES CONSUL R. M. BARTLEMAN, Cienfuegos, Cuba, in a report to his Government published in the Commerce Reports, says that a very fair demand for gasoline motors exists in the Cienfuegos district, but on account of the excessive advance in the price of gasoline there is a tendency to turn to the crude-oil engine.

The following quotations have been obtained: 1¾ horse-power, $78; 1½ horse power, $55; 4¼ horse-power, $95; 4 horse-power, $180; 6 horse-power, $185, $215 and $375; 8 horse-power, $285.

Dealers also offer a complete plant for lighting and industrial purposes (the heating feature being superfluous for this climate), consisting of engine, motor and storage battery, with a capacity for 10 lights, costing at factory $150, placed on market here at $240. Others, of 20-light capacity, with a factory cost of $200, sell here at $320.

Electricity and Hydraulics

COMMUTATOR TROUBLES

Vulcan Staff Article.

AS commutator and brushgear are the most frequent sources of trouble in direct-current motors, a few remarks on the care required to maintain these details in order may be of service to operators and attendants generally. The commutator is, perhaps, the most sensitive detail and deserves more attention than it usually receives, though, given proper design, it should not require more attention than is called for with ordinary wear and tear. The secret of success of satisfactory running depends on three important points:—

1—Correct brush position relative to field poles of machine.

2—Correct spacing of the brushes round the commutator.

3—Good contact between commutator and brushes.

Correct Brush Position

Correct brush position is a condition that can best be arrived at by trial, but under normal conditions the heel of the brush should be very nearly opposite the centre of the corresponding shunt field coil. In the case of a multi-polar machine, the number of commutator sections between each pair of adjacent brush arms should be equal, and, once set, this condition will remain, except after such times as the machine is dismantled for cleaning or repairs, when it sometimes happens that the spindle carrying the brush boxes receives a twist sufficient to displace the brush on the commutator surface as much as the width of one or more bars. Sparking trouble may, however, remain even if correct conditions are complied with, should brushes and commutator fail in making good contact.

The chief cause of this is known as "high mica," and is due to the copper sections of the commutator being softer than the intervening mica sections, with the result that the copper burns or wears away at a greater rate and leaves the mica projecting above the copper. This is most liable to occur in commutators having a large number of thin bars, and where, therefore, the percentage of mica is high as compared to the copper. The amount the mica projects is, of course, only small, and can best be detected by drawing the finger nail along the radial surface of the commutator. This small projection, however, is sufficient to cause the brushes to lift and spark as the machine revolves. If not attended to at once, this sparking may eventually become so bad that the machine is unsafe to run, or may not even run at all. Any polishing or grinding that can usually be applied has the tendency to clean up the copper, but still allow the mica to be upstanding, and it is necessary to recess each mica section to a depth of about 1-32 in. to 1-16 in. below the surface of copper.

With recessed mica the brushes are able to maintain uninterrupted contact and eliminate the burning and sparking, thus increasing the life of the commutator and the brushes, reducing the temperature and generally improving the operation of the machine. There is one drawback, however, to recessed micas: carbon and other dust can accumulate in the cavities thus made, and such material being more or less a conductor, causes shorting of adjacent copper bars, with consequent burning out of coils. If, however, the slots do not exceed the depths given, and the commutator is periodically blown free from dust and no oil is allowed to get on to the commutator, there should be no trouble.

Breakdown Experience

In connection with this subject of commutator troubles, a breakdown which recently came under the notice of the Vulcan Co. electrical surveyors is instructive. A large d.c. generator recently broke down, due to a "flash over" at the brushes, and two large holes were burnt through the mica end ring and into the cast iron clamping ring, and three of the commutator bars had about 2 in. fused off the ends. A few days afterwards, notification was made of a breakdown to another d.c. generator, some of the armature coils having earthed. The inspector sent to examine it reported that shortly after the first accident the engineer-in-charge noticed smoke issuing from the armature of the second machine, which was standing at the time, and on investigation found that some dirt in one of the air ducts between the windings was on fire. As he could not extinguish it, he injected some water, which undoubtedly damaged the insulation and resulted in the earthing of the coils. It was afterwards established that a piece of molten metal from the fused end ring of the first-mentioned generator had been thrown off and dropped down the air duct of the standing machine, setting fire to the dust in the air duct. Pieces of molten metal also fell on the main switchboard about 30 ft. away.

HYDRAULIC RESOURCES AND INDUSTRY

IN estimating the value of Canada's hydraulic resources and their importance with reference to future industrial development, the extent to which electro-chemical processes have entered into some phases, at least, of nearly every branch of our industrial life is not generally appreciated.

A small beginning in electro-plating, two generations ago, has developed until the great bulk of the copper output of the world is electrolytically refined. The electrolysis of common salt is the basis of the electrolytic alkali industry, the products of which are caustic soda, metallic sodium, chlorates, and hypochlorites. The electric furnace has created a host of new industries, producing chiefly abrasives, graphite, silicon, ferro-alloys, refined steel, phosphorus and calcium carbide. It has also been tested experimentally as a competitor of the combustion furnace in the metallurgy of many metals.

Used as an electrolytic furnace, we have the very important application to the production of aluminum. The industrial use of electric discharges through gases is still in its infancy, but we have ozone and nitric acid among the products, the former used for sterilization, and the latter as a basis for fertilizers and explosives.

Every one of these industries consumes large quantities of energy. Whereas the refining of lead requires only 120 k.w.h. per ton, we have consumptions as high as 4,000 k.w.h. per ton for other metals. The aluminum furnace requires 25,000 k.w.h. per ton of product.

The electro chemical industries have grown to be of great value to countries which possess good opportunities in water power resources, as they have a fundamental interest in the development of cheap power.

LUBRICATION

By R. W. Reay.

THE question of lubricants and the method of their application require more careful consideration now than was the case a few years ago owing to the rapid development of the internal combustion engine and the more prevalent use of high temperatures and pressures in steam engines. The present-day aim is to secure higher efficiency and greater reliability. To this end lubrication be-

comes a very important factor. The efficiency of an engine is greatly impaired by the use of an unsuitable low grade lubricant.

In the selection of an oil, one should be guided more by the results derived from its use than by its gallon cost. It is necessary when selecting an oil to know the actual conditions under which it is expected to work. The question must be studied for each particular type of engine, and thought must be given to tthe type of lubricating appliance in use, because wrong application or overfeeding of oil is often the cause of serious trouble. The main function of a lubricating oil is to create a complete film between the rubbing surfaces, thus preventing metallic contact. The two chief properties in a lubricating oil are:—The quality of oiliness "body," and the viscosity.

Speaking generally, the greater the load upon a bearing the more body the oil must have to carry the burden, while with regard to viscosity the oil possessing the lowest viscosity in conjunction with sufficient oiliness to form a complete oil film will give the least co-efficient of friction. It is, of course, necessary that the oil should maintain these properties when in the form of a thin film in which state it exists between the rubbing surfaces, and it should neither evaporate nor become gummy during use.

Steam Cylinder Lubrication

When selecting an oil for steam cylinders and valves, two important factors to be considered are the type of engine, whether vertical or horizontal, and the steam temperature. The oil that would suit and give the best satisfaction on a high speed vertical engine would not be the most suitable for the slow running horizontal, owing to the weight of the piston having to be carried by the oil to prevent metallic contact with the lower side of the cylinder.

Where superheated steam is employed, the oil is not washed out of the cylinder by the condensation of steam, but remains for a long time exposed to the high temperature, so that the best quality cylinder oil applied in a proper manner should be used. If an unsuitable oil is used, a carbon or sticky deposit will result.

Marine Engine Lubrication

The syphon system is commonly used for the external lubrication of marine engines, though in some cases the method of hand oiling is still adopted. The great drawback of the latter is the intermittent supply. The bearings get more oil than is necessary at the moment and are almost dry before it is again applied. With the syphon system there is a uniform flow on the bearings giving even lubrication with little or no waste. The oil most suitable for marine engines is one that will emulsify with water. There is always a certain amount of condensation taking place, due to leakages from piston and valve rods, and, therefore, the lubricating properties of such an oil are less effective than oils purely mineral in character.

A firm that had been using low-priced oils decided to try if they could obtain more economical results with those of high grade. The engine is a 500-h.p. vertical steam unit, driving a large factory. Before changing the oil they ascertained the number of free revolutions with all the belts through the factory on loose pulleys. This was done by starting the engine at lunch hour, and, on reaching the normal speed, the throttle valve was shut and the number of free revolutions made by the engine recorded. An average of three days was taken and found to be 47 free revolutions.

The new oil was then put on, and after eight weeks' running an average of three days was again taken. This time 57 free revolutions were obtained, showing an increase of 10 revolutions. The conditions in each case were exactly the same, the speed of the engine being indicated by a tachometer showing exactly the same number of revolutions on each occasion at the point of closing the valve, and despite the fact that the high grade oil cost more, the actual running cost worked out lower, as there was less being used. A test of this sort can often be easily carried out, and being absolutely reliable is a good object lesson.

A good deal of trouble is often caused by overfeeding of cylinder oil. One case of this came before my notice recently. The engine was a 50 h.p. triple expansion horizontal steam unit. On the cylinders being opened, they were found to contain an abnormal amount of carbon deposit. When the engine was again started, the feeds were reduced to exactly one-fifth the previous amount. After running some time, the cylinders were again examined and found to be in splendid condition with no trace of carbonisation.

Diesel Engines

In the early days of the Diesel engine a considerable amountof trouble was experienced, due to breakdowns. It was found in many cases the trouble was caused by the piston "seizing" in the cylinders. The lubricant used was not suitable to the intense heat to which it was subjected. The pistons are lubricated by a mechanical lubricator, one pipe being led from the lubricator to each cylinder and a number of branches, usually 4 or 8, taken from this and led through the water jacket at various positions round the cylinder. A better method would be to have a separate pump for each entrance, two feeds (front and back), for pistons up to 20-in. diameter, as the greater part of the feed is liable to go in at the point nearest the lubricator and the point furthest away would get little or no oil. The proper place to inject the oil is between the first and second rings when the piston is at the bottom of the stroke. This can only be done by employing a mechanically-operated lubricator of a special design.

The majority of Diesel engines are open type. The gudgeon pins are lubricated by a mechanically-operated lubricator through the cylinder wall; a scraper attached to the gudgeon pin scraping off oil from the cylinder wall and guiding it into the gudgeon pin bearing surfaces. Main bearings are nearly always ring oiled and crank pins banjo oiled. The force feed circulation system is frequently used for bearing lubrication. Splash guards are sometimes fitted in the crank chamber having openings for the connecting rods. This prevents the oil leaving the crank webs from reaching the cylinder walls.

An oil must be selected to suit the conditions, and be of the best quality obtainable since the oil in the crank chamber is nearly always affected by the admixture of liquid fuel. Any fuel oil that has not been properly burned mixes with the oil on the cylinder walls and gradually works past the piston rings into the crank chamber, the result being that the oil becomes contaminated and its lubricating properties impaired. The carbonised matter coming down from the piston makes the oil dark in colour.

With the forced feed circulation system, there is a great likelihood of the oil, which is constantly being splashed to the cylinder walls passing the piston rings and getting to the top of the piston, where it will be burned and leave a carbon deposit. This is sometimes provided against by having the rings pegged, so that, after working a little while, they adapt themselves to the shape of the cylinder, this preventing the oil from passing, and the explosion gases from blowing past into the crank chamber. When the piston rings are not pegged, a very heavy-bodied oil is used to seal them. This is not an advisable practice. The heavier the oil the more power is lost through friction, and a greater carbon deposit formed on the piston rings. If too thin an oil is used it will pass to the top of the piston in large quantities, which means heavy consumption and excessive formation of carbon. Oils properly selected and manufactured have considerably longer life in the circulation system than ordinary oils improperly manufactured or not selected with the same care.

The temperature inside the crank case is usually high in enclosed engines owing to the fact that the pistons get less cooling from the air and the hot gases occasionally escape into the crank chamber. When using a high class oil, the friction is considerably reduced, the crank case temperature is lower, less power is needed to overcome friction, and less wear and tear of the working parts will result. From a paper read before the Institute of Marine Engineers.

Use of oil in generating power is much more effective when applied to internal-combustion engines than when consumed as fuel under boilers. In the one case a barrel of oil gives power for crushing 14 to 15 tons of ore; in the other only for 1¾ to 2 tons.

REFRIGERATION DEPARTMENT

FLOODED SYSTEM OF REFRIGERATION

By S. S. Wyly.

ONE of the recent developments in the field of mechanical refrigeration is the application of what is commonly termed the flooded system. It is not, as may at first be supposed, a distinct system of refrigeration; instead it is an improvement in that part of the ordinary system in which the freezing or refrigerating effect is produced. In the ammonia compression system, as applied to the cooling of brine for ice-making or indirect refrigeration, the liquid ammonia from the condenser is collected in a receiver, from which it is led to the expansion valves and allowed to pass through into the pipe coils in the brine tank. In passing through the expansion valves from the high pressure side to the low pressure side, the liquid ammonia is converted into gas, the heat for this evaporation being taken up from the brine surrounding the coils. Thus, the evaporating coils are filled with gaseous ammonia at a low temperature and pressure.

Evaporating Coils Content

The flooded system differs from the foregoing in that the evaporating coils are flooded with liquid ammonia; that is, the interior of the coils, instead of being filled with ammonia gas, are kept nearly or quite full of ammonia liquid. The object of this is to obtain an increased efficiency by reason of a more rapid transfer of heat from the brine to the ammonia. The increased rate at which heat is transmitted is due to the fact that both the inside and the outside surfaces of the pipe coils are wetted by contact with liquid. One of the proved facts regarding heat transmission is that a greater quantity of heat can be transmitted per square foot through metal plates from one liquid to another than from a liquid to a gas or from a gas to a gas, other conditions being the same in all cases.

Because of the flooding of the expansion coils, each square foot of pipe surface is able to transmit from 50 to 75 per cent. more heat per degree difference of temperature, than when the coils are filled with dry gas and the heat is transmitted from a liquid to a gas. Of course, the more rapid the heat transfer, the greater the refrigerating effect produced in a given time, and the higher the efficiency of the system as a whole.

*From a paper read before the Kentucky Ice Manufacturers' Convention.

Since the coils are practically filled with liquid ammonia, the evaporation required to maintain the brine at the desired temperature produces a mixture of gas and liquid in the pipes. Consequently, in the suction line to the compressor there must be a separator or trap by which the liquid and the gas will be separated, so that only dry gas will be drawn into the compressor cylinder; and the liquid thus separated must be returned to the coils.

The Accumulator Device

The device by which the gas and the liquid are separated is called the accumulator. The suction line to the compressor leads from the top of the accumulator, and the line from the bottom leads back to the liquid header, a check valve being inserted in this line to insure correct operation. The gas is drawn from the suction header above the evaporating coils through a pipe into the top of the accumulator, on its way to the compressor. In the accumulator, which is a vertical cylindrical chamber of considerable length, the liquid ammonia falls to the bottom and from there flows by gravity through the pipe back to the expansion coils. Since the interior of the accumulator is subjected to the suction pressure there is a tendency to cause a flow back through the pipe from the liquid header. To prevent any such flow, a check valve is placed in this line which will permit the liquid ammonia to pass to the expension coils, but will not permit it to return by the same pipe. The result is that the flow is confined to the one desired direction.

In the process of cooling the brine surrounding the coils, the heat transmitted to the ammonia causes some of it to evaporate, so that the coils contain a small proportion of gas. If it were not for the check valve, the gas in the lowest coils would be drawn back through the pipe, from accumulator to coils. The level of the liquid in the accumulator is shown at all times by an indicator attached to the side of the accumulator. The feed through the expansion valve need be only sufficient to maintain the proper temperature in the brine tank.

This describes the flooded system as applied to the ice-making system in which there are coils arranged in sections. Each section is a divide between each row of cans. These coils are built up about eight pipes high and of such length and number of coils as is necessary to contain about 300 lineal feet of 1¼ in. pipe per ton of ice made in a day of 24 hours, all of this to be arranged into a tank of such size as will accommodate coils and ice cans, the coils and cans being submerged in brine of such density as not to freeze.

Shell and Tube Brine Cooler Type

There is one other flooded system that has been in use for the last few years, which is known as the shell and tube brine cooler, so arranged at one end of the ice-making tank that the brine can be drawn or forced through the tubes to the brine cooler. In this process, the brine is cooled to the desired temperature and then sent to the ice tank, which is arranged without coils—nothing but the cans filled with water to be frozen. The tank is so arranged with partitions that the brine passes very rapidly through the tank and back to the cooler where it is recooled, and thence through the same operation again.

With the shell and tube brine cooler you will note there was no accumulator mentioned. This is due to the fact that there are no coils connected, the brine cooler being simply a shell filled with 2-inch tubes and placed as close together as is consistent with good designing, for strength. The liquid anhydrous ammonia is fed into the shell at a rate to guarantee the proper height of liquid to be carried in the cooler, which is about two-thirds full, the cooler being in a horizontal position. As the heat from the brine is transferred through the tube to the liquid ammonia, the liquid is evaporated into dry gas, just the same as steam is evaporated from a horizontal return tubular boiler. The evaporated gas passes off at the top of the cooler to suction line of the compressor or the return line of the absorption machine. The amount of gas that is thrown off at this cooler determines the size of the machine, whether it be a compression or an absorption machine.

The Economy Feature

It will be noted that no mention has been made of economy, which is the most important item to be considered when entering into a new method. The very first thing that is considered when contemplating an improvement of any kind, is, how much is the investment? How long will it take to pay out, and how much is it going to increase our net earnings? I don't believe I have ever found an instance of a material saving having been made. If we make a new installation, the cost of the accumulator and extra charge for ammonia will about offset the amount of cooling surface that has been saved by the rapid transmission of heat through a smaller

number of square feet of cooling surface; and as to making a change, it would be useless to go to the expense of equipping an existing dry gas system with one that will increase the output of the freezing system only.

Bear in mind, I am basing this statement on the fact that you have a machine that is capable of handling a a given number of heat units every 24 hours, and by adding a new system that produces twenty or twenty-five per cent. heat units per twenty-four hours, the machine with its respective parts will have to be increased (or, if with a compression machine the speed will have to be increased), using steam at the same ratio as in the former case. Quoting from a previous article of mine on this subject, "three hundred feet of 1¼-inch pipe is used per ton of ice in the ice tank, when with the flooded system only half or two-thirds this much is needed," and just recently I find published in one of our popular journals an article describing a most modern and up-to-date ice plant where, even with the flooded system, they are still using 14.3 cans per ton and 300 feet of 1¼-inch pipe per ton, and to-day, under the dry gas system, at one of our plants we have five hundred and thirteen 300-pound cans with 300 feet of 1¼-inch pipe per ton, pulling 240 blocks of 300 pounds of ice each twenty-four hours, which is 14.1 cans per ton.

Question of Adoption

It is not the object of this paper to take issue against the flooded system, for, from foregoing part of paper, it is a foregone conclusion that the flooded system will transfer heat more rapidly than the dry gas. It will be noted that I have put the question as if it is applied to a specific case; in other words, to determine whether it is necessary to change present equipment to the flooded system, which is practically using the same material as in the old-fashioned dry gas system.

Reference has been made to a tank with 513 cans producing 36 tons of ice, which is equivalent to 14.3 cans per ton. We also have another plant where the circulation is better and are producing 72 tons of ice per day on this tank of 960 cans, which is equivalent to 13.5 cans per ton. This is about as good a record as can be produced on ice-making tanks, for if you use a smaller number of cans per ton, it will be necessary to carry such extremely low temperatures as to result in cracked ice.

GEAR WHEEL PRACTICE

IN the old mill-wrighting days, says The Power User, whenever it was desired to transmit power from an engine to various pieces of machinery, advantage was taken of the peculiar conveniences that gearing offers, much more than is the case at the present day, notwithstanding the great improvements that have been made in late years in the production of toothed gears. Some fifteen or twenty years ago the writer had to scheme out a drive for a factory in which one place, and one place only was suitable for placing the steam engine, the installation of which he was responsible for. It was in a recess cut out, cave fashion, in the side of a chalk cliff at right angles to one long room furnished with various machines. In a second room, at an obtuse angle with the first, other machines were placed, and, being brought up to belt drives almost exclusively, attempts were made to solve the problem of driving the two inclined shafts by belting from the engine.

All sorts of schemes were considered, but all difficulties were solved by an engineering colleague in the simplest manner. Careful measurements enabled the exact angle to be determined, and a pair of bevel wheels were cast to gear at that angle and the puzzle was solved. It was a lesson that has never since been forgotten. Yet one rarely finds that any other than parallel and right angle drives are arranged for to-day, although, in many instances of irregularly shaped structures, it would often be a convenience if bevel wheel drives arranged for the required angle were adopted. Is many cases it would be possible to arrange the machinery to much better advantage and thus to obviate waste space.

This experience was called to mind by listening recently to an informal discussion by the members of the Junior Isstitution of Engineers in London upon the subject of gearing. The speaker who opened the subject was an expert on gears and gave some interesting information of general interest. He spoke of the various types of gearing used to-day for different purposes, of their characteristics and their limitations, and advised his hearers to "leave it to the expert." It was a little difficult to accept this advice, however, for he instanced shortly afterwards, as an example of unsatisfactory operation, a case in which a firm specialising in worm reduction gears failed to do what was required, as the circumstances were such that double helical gears would have been much more suitable. That is the worst of relying upon gear makers' advice. They are so apt to quote for what they are, for the nonce, specializing upon, to promise for their products of the moment rather more than can be or ought to be claimed.

For reasons which will be obvious to our readers, it is undesirable to make comparisons between different specialities in commercial competition, but it may be said that in the writer's own experience the advice of power gearing "experts" proved to be somewhat unfortunate and expensive. Making a spe-fortunate and expensive. Making a spe-a pair of wheels was supplied by a certain firm in connection with an electric motor, the pinion being keyed to the motor shaft, and the spur wheel on the main shaft transmitting the power to several machines. When set to work the gears worked very noisily and soon showed signs of undue wear. The writer's opinion was sought, and it was very evident that the wheels were endeavouring to preserve one fixed relative position of contact with engaging teeth, while the "floating" of the motor armature was pulling the teeth out of this natural line of contact.

The advice was given to key the pinion in such a position on the motor spindle that, when at work, the magnetic centre of the armature would be gained and would keep the pinion teeth in correct line of contact with the wheel. This however, was easier said than done, for variation of output could not be obviated, and the armature continued to float in consequence and did not keep to a definite magnetic centre. This defect is a well recognised one in any form of tooth gear which necessitates strict alignment of engaging wheels, and to get over such difficulties it is often specified that flexible couplings be provided on either side of the gears.

In a gas or oil engine drive, for example, when it is requisite for an engine speed of 250 to be increased by gearing to actuate a centrifugal pump spindle running at 900, then it is advisable to fit a flexible coupling on the engine shaft and another on the pump shaft; and, more than this, to adopt adequately proportioned bearings to the two spindles of the gears so as to firmly support them on both sides; to provide for adequate lubrication of the four bearings, and to project a stream of oil, preferably under pressure, at the point of tooth engagement to minimize wear, and particularly so when the pitch velocity is fairly high.

An Interesting Study

Gear wheel practice is a very interesting study to-day and it is a subject which should not be "left to the expert" with blind confidence. Factory engineers have bought much experience at too great cost by so doing, and it behoves them to at least know sufficient about the subject as will enable them to discriminate the relative merits of commercially competing tooth formations. It may be true that a worm drive is comparatively inefficient when compared with others, but there are many cases where a worm drive is the only practicable one, and therefore its relative inefficiency is of no consideration.

In the discussion to which allusion has already been made, the "hunting" tooth was referred to. It seemed that the very advantage of the hunting tooth was to-day considered a disadvantage by the expert who suggested—apparently seriously—that if this hunting tooth was a shade tighter than the others, then it would wear unduly every tooth in the engaging wheel, whereas if it were omitted all teeth would be worn evenly. He seemed somewhat surprised when it was suggested to him that he had raised a bogey just for the sake of knocking it down, seeing that there was no reason is the world why the hunting tooth should be any different to the others in a gear wheel. As a matter of fact it is to ensure regular wear of all teeth that the one extra or "hunting" tooth is provided.

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Vol. X. FEBRUARY, 1917 No. 2

PRINCIPAL CONTENTS

Engineering Laboratories of the University of Toronto 21-28

General 28
Obtaining Draught Without High Chimneys.

Light, Heat and Ventilation 29-31
Heating and Ventilating Residences in England.

General 31
Recovery of Lubricating Oils....Boiler Inspection at Montreal....Cuban Demand for Gasoline Motors.

Electricity and Hydraulics 32
Commutator Troubles .... Hydraulic Resources and Industry.

General 32-33
Lubrication.

Refrigeration 34-35
Flooded System of Refrigeration.

General 35
Gear Wheel Practice.

Editorial 36
Help to Win the War....Future Aspects of Skilled Labor.

The Operators' Point of View 37-38
Home-made Check Valve for Boiler Test Pumps....Two Useful Kinks....Elevating Platform....Detecting Leaky Blow-off Cocks....Adjustable Supporting Post.

Operators' Instruction Course 39-41
Concerning Indicator Diagrams—V.

General 41
Exhaust Mufflers for Oil Engines .... C.A.S.E. and Graded Certificates.

Questions and Answers 43-43

Steam Power Plant Auxiliaries 44-47
Steam Separators—I.

General 47
Chimney and Mechanical Draught.

Progress in New Equipment 48
Single and Multi-Stage Steam Turbines....Protection-Edge Laminated Belting....Machinists' Screw Driver ....Large Electric Motor.

Selected Market Quotations (Advtg. Section) 64

Projects and Developments 71-72

Catalogues, Book Reviews 72-73

FUTURE ASPECTS OF SKILLED LABOR.

ONE of the principal handicaps which manufacturers are likely to encounter in this country, in the generally expected struggle for after-war trade, will be the obtaining of a supply of suitably trained labor. Observers, both in Britain and America are noting closely the present tendencies of the situation, and where possible are exerting personal influence to the end that the employee's interests in obtaining a proper training are too closely identified with the employer's to permit the latter to ignore the facts of the case indefinitely.

A few mechanics are born, some are trained, but a large proportion are the creatures of circumstances, who started in a machine shop as boys glad to get rid of school studies and brain work of any description. Perhaps the machine shop was the only local opportunity; had it been a packing-house or a cheese factory, they would have started there for just the same reasons. Such youths seldom remain long enough or work seriously enough to imbibe any ideas of the trade's requirements; they may ultimately manage to read a micrometer and yet be unable to work a problem in decimal fractions, and no one cares, at the time.

These conditions have been common in the past—most of our readers are probably able to recall such individuals and occurrences—and all of them have doubtless agreed that when all was said and done, the employers have themselves to blame, because they don't want to spend their own time or money training help for the ultimate benefit of other firms, and when the majority of employers view the situation thus, no remedy seems applicable.

Nothing but a return to ordinary commercial work will bring about the previous state of affairs. The repetitive feature of shell production will not be present, and the efforts of this country to build up a foreign trade will involve for some time a variety of manufacture, throughout the country generally, and in many shops in particular, which will create a real demand for the all-round machinist, and it is in their efforts to anticipate this demand that manufacturers, who are laying plans for the future, have opportunity for displaying a degree of prescience, indicative of their ability to play a larger part in the future upbuilding of our industries.

HELP TO WIN THE WAR

THOSE who cannot go to the Front can help in a most practical way by saving their money and placing it at the disposal of the Government to assist in financing the war. The new War Savings Certificates which have been created by the Government to encourage thrift and economy, and to give everyone an opportunity to assist in financing our war expenditure, are now on sale at every bank and money order post office in Canada. The $25 certificate sells for $21.50, the $50 for $43, and the $100 for $86. As an investment, these certificates offer many attractive features—chief of which are the absolute security and the excellent interest return. For every $21.50 lent to the Government now, $25 will be returned at the end of three years.

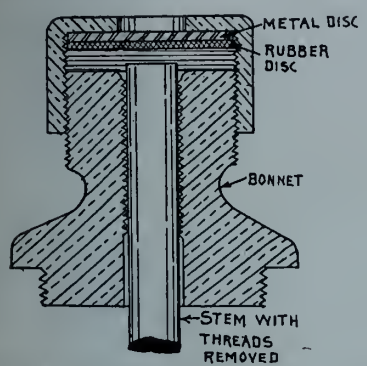
There are two other features which are especially interesting to small investors. First, the certificates may be surrendered at any time, if the buyer should need his money; and second, each certificate is registered at Ottawa in the buyer's name and, if lost or stolen, is, therefore, valueless to anyone else. Notwithstanding their excellence from an investment standpoint, the certificates should appeal strongly to our people, because they offer to those who must needs remain at home a splendid opportunity for a most important patriotic service.

The Operators' Point of View

HOME-MADE CHECK VALVE FOR BOILER TEST PUMPS

By J. E. McCormack.

EXPERIMENTING with home-made force pumps for boiler test purposes, the writer found it convenient to utilize a couple of old globe valves from the scrap, which



HOME-MADE CHECK VALVE FOR FORCE PUMP.

were quite capable of withstanding the occasional pressure demands without break or leakage, even though not quite suited for continuous operation. Many globe valves, especially those with renewable faces, are ultimately scrapped through failure of threads, either on the valve stem or for the stuffing nut to screw on to. The failure of either of these renders the valve useless for its original purpose, but with a small amount of doctoring it will serve very well as an extemporized check valve.

The first thing to do is to grind the threads off the valve stem so that it will slide freely back and forth in the bonnet without sticking. Now remove the stuffing nut, assemble the parts together and mark the valve stem level with the top of the bonnet, cutting it slightly shorter than the mark, according to the amount of lift desired. A metal disc is now made a fairly close fit for the inside of the stuffing nut, a rubber disc being also made to fit in the same place. The sketch shows the parts assembled, but not tightened down into position. When the stuffing nut is screwed home, the rubber disc makes a tight joint with the top of the bonnet and prevents leakage from the valve stem, the lift of which may be increased at any time by cutting more off the end. Should the threads on the bonnet be badly worn, the top of the bonnet may be cut down some so that the stuffing nut will get a hold of the unworn threads. Should this fail there is frequently enough metal to allow of a standard pipe thread being cut, to accommodate a pipe cap in place of the stuffing nut.

These valves, of course, are not suited for continuous operation, but, when tried out with a force pump on boiler test work at 100 lbs. pressure, operated quite as satisfactorily as entirely new check valves.

TWO USEFUL KINKS

By John Thorn.

TAKE an ordinary monkey wrench, drill two holes in the jaws for ¼ in. steel pins, cut a slot in the upper jaw to admit an ordinary cutter wheel, and another slot ⅜ inches wide in the olwer jaw for a roller; a cutter wheel can be used instead of the roller if desired. This converts the wrench into a passable iron pipe cutter, Fig. 1. By removing the pins and cutters, the wrench can be used as usual.

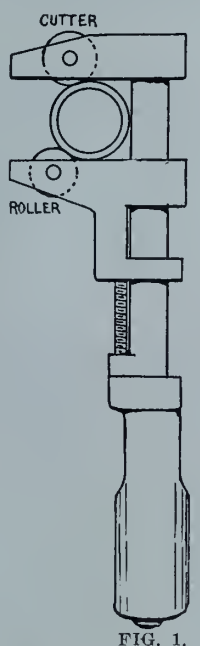


FIG. 1.

Another useful idea is shown in Fig. 2, this being a pump for testing pressure gauges. The body is a piece of 1½ in. heavy brass pipe, threaded at each end with standard pipe threads; a light cap is put on one end, while on the other end is threaded a heavy cast iron cap drilled in the centre and tapped for an ordinary ⅝ in. bolt. A long stem, with a T-handle, is threaded nearly the whole length as shown. This stem is a piece of ⅝ in. iron or brass rod which, with two iron washers, nuts and a cup leather, forms a plunger. A test gauge and a gauge to be tested are attached to the elbows at A and B.

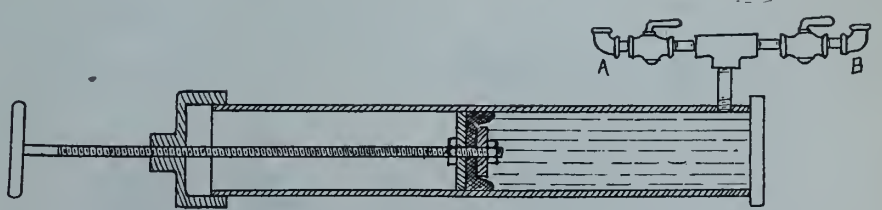


FIG. 2.

Before testing or attaching the gauges, place the lower elbow in a dish of water and leave the pit cock at B open and the one at A closed. Screw the plunger down as far as it will go, and then turn it back to the upper position with the elbow under the surface of the water; this will fill the pumps with water. Attach the gauges, open the pet cock and turn up on the T-handle, when a pressure of several hundred pounds can be secured with ease. The reason for using brass tube is because the inner surface of brass tube is usually much smoother than iron.

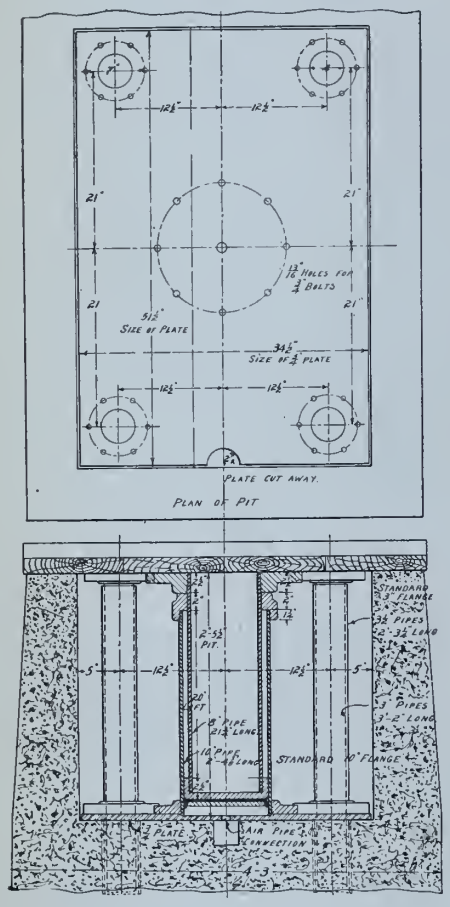
When a gauge is either weak or strong, all that is usually necessary to put it right is to remove the pointer and dial, oil the inner mechanism with a little coal oil, using a tooth brush (be sure none of the bristles are left behind), and replacing the dial and pointer so that it will just rest against the pin. Of course, if any cog or sector teeth are broken, or the spring tube is leaking, that is another story; but nine times out of ten all that is wrong is the pointer. The writer remembers once finding five pressure gauges in a plant, all of which had been discarded as useless, and in less than an hour had tested all of them, moved the pointers, and after testing again, they were absolutely correct with the test gauge. Gauges should not be placed where they will become hot, and steam should never be allowed to enter the spring, either of which conditions will ultimately destroy its usefulness.

ELEVATING PLATFORM

By E. T. S.

ALMOST every manufacturing plant has a lifting proposition somewhere or other, in which the lifting platform style would be the ideal thing. The method outlined in the following may be very simply arranged in plants where compressed air is employed, for the rea-

son that practically the whole outfit is made from standard pipe fittings. The elevating platform, shown in diagram, shows the simplest form of this arrangement with a single piston. We have in use at our plant several of these elevators which have a second piston, that is to say, the telescopic pipes comprise three pipes instead of two as shown. The base of the outer pipe is simply a pipe flange which is bolted to the base plate covering bottom of pit; a hole in the centre provides the air inlet. The top end of this outer pipe is threaded on to a reducer coupling bored out to suit size of inside pipe. The bottom end of the inside pipe is fitted as a piston with a single leather packing ring, and at the top end is a standard flange to which is attached the elevating platform. If the platform is large, it is necessary to provide guides in order to steady ascent



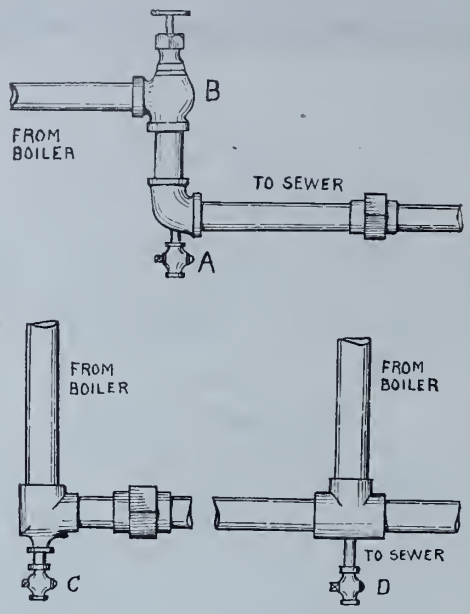
ELEVATING PLATFORM DETAIL.

and descent. For these guides we have four pipes 3½ inches diameter, into which slide four pipes 3 inches diameter. The larger pipes are fitted with standard flanges, and bolted to bottom plate, while the smaller pipes are similarly fitted and bolted to underside of platform. The whole is built up in a concrete pit having the platform ground level, so that trucks can be run on easily, and is controlled by a standard ¾ inches four-way valve. It is a low-priced elevator, gives good service, and hard to put out of service.

DETECTING LEAKY BLOW-OFF COCKS

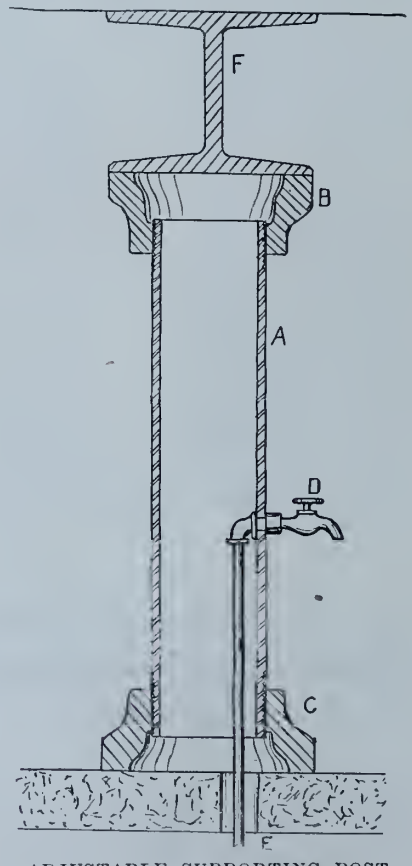
By E. N. Port.

THE majority of blow-off pipes which are connected to sewers or outside tanks, have no openings to show if the blow-off valves are leaking. Some of them



ARRANGEMENT OF BLOW-OFF PIPES FOR DETECTION OF LEAKY COCKS.

have tees instead of elbows, attached to the pipe, on the sewer side of the valve, with a plug screwed into one opening of the tee. Perhaps this plug may be removed "once in a blue moon" to see if



ADJUSTABLE SUPPORTING POST.

there is any leak, and perhaps not. A simple but good idea is to attach a small plug cock as shown at A. If two or more boilers are in a battery, different cocks can be attached, as at C and D.

It is no trouble to open one of these small cocks, and by doing so it can be seen instantly if the blow-off cock is leaking. A flange or union should always be placed near a blow-off cock so that the valve can be removed for repairs at any time without taking out a long stretch of pipe.

ADJUSTABLE SUPPORTING POST

By L. U. N.

AN adjustable pipe post is shown in the accompanying sketch, made from 6-inch steam pipe threaded right hand on one end and left hand on the other. Two heavy cast iron flanges are shown on the ends at B and C. This post can be placed under a ceiling or I beam already in place and by using pipe tongs to unscrew the pipe a few turns, a tight bearing can be made, the flanges being held with chain tongs while the pipe is being unscrewed.

In the post shown, a hole has been made in the concrete floor at E large enough to allow the elbow on the water pipe to pass through, a hole being drilled in the post to allow a nipple to pass through freely, and a drinking tap connected as shown at D.

REVENUE INCREASE

A JUMP of some $50,000,000 in the revenue of the Dominion for the last 10 months is indicated by the financial statement covering that period issued on Feb. 9. The total for the 10 months was $187,903,565. The increase for the month of January, when $21,047,216 was taken in, was about $4,000,000. The increase in general expenditure during the 10 months was about $10,000,000, the total expenditure on capital and war accounts being $215,521,914 for the 10 months, and $26,318,529 for January. On consolidated fund the expenditure for the 10 months was $187,903,565, and $18,882,897 during January. In the 10 months' total the principal items of revenue were $108,868,302 from customs, $20,561,709 from excise, $15,881,627 from post office revenues, and $21,701,730 from railways, canals and public works. There was an increase of some $23,000,000 in the net debt which is now $745,438,869.

Steam Boiler Safety Valves.—In any safety valve there are three factors which affect the rate of flow over the seat that are characteristics of the seat itself, namely, the vertical lift, the seat angle, and the contour of approach to the seat. The flat seat is adapted to open the largest area per unit of vertical lift and should be employed—other conditions being equal.

Operators' Instruction Course

CONCERNING INDICATOR DIAGRAMS—V.

THE present article concludes the series on Indicator Diagrams, and in view of the fact that those preceding have dealt almost entirely with their reference to the steam engine, it seems fitting that in the present instance something should be said concerning indicator diagrams in connection with modern gas and oil engines.

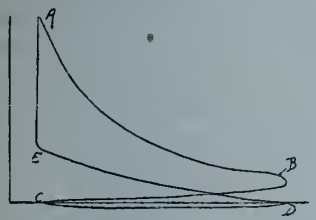


FIG. 26.

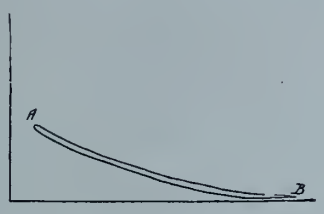


FIG. 27.

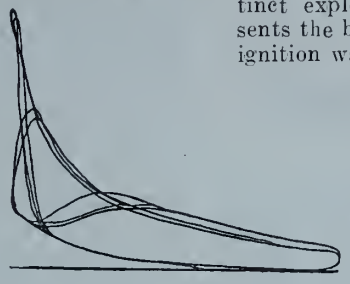


FIG. 28.

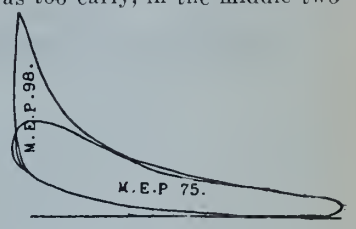


FIG. 29.

Indicating Gas Engines

While the indicator is necessary for determining the I.H.P. and efficiency of gas engines, it can also be made to serve a large number of other useful purposes when the right kind of indicator is used, and when its many applications are fully understood. For instance, the gas engine indicator can be made to show the following: Timing of ignition; overrichness or leanness of the mixture for different conditions of atmospheric pressure and humidity; the proper timing of the exhaust and inlet valve events; whether the exhaust and inlet valve passages are of the right proportion or are clogged up due to deposits of soot, or have too many bends, and other uses as mentioned in the following description.

A well-known type indicator, especially adapted for indicating gas engines, embodies in its make-up two cylinders and two pistons. The regular piston has an area of one-half square inch, but by removing this piston and inserting a smaller one in a sleeve in the main cylinder, the effective area of the piston is reduced to one-quarter square inch, thus giving double the range of pressure for the same travel of the pencil point. In other words, if a 100-lb. spring is used in connection with the ¼-inch piston, each inch height of the indicator card represents 200 lbs. pressure. As the pressure in gas engines often runs to four or five hundred pounds, the advantage of these two pistons will be apparent.

Fig. 26 shows a typical gas engine card taken with a heavy spring, except that the suction and exhaust lines have been exaggerated so as to be visible. The line C to D represents the suction stroke. If this line drops very much below the atmospheric line, it indicates that the area of the suction pipe is too small, that the valve opening is too small, or it may be caused by too many bends or short elbows in the suction pipe; DE represents the compression line. At E the explosion occurs, and the pressure jumps quickly up to the point A. Line AB represents the expansion of the gases. At B the exhaust valve opens. This should be at from 85 to 90 per cent. of the stroke. Exhaust or pushing out of the burned gases, is represented by BC. The exhaust line should be close to the atmospheric line. If the line BC is too high it may indicate that the exhaust line is choked, or it may also be due to the cause mentioned above concerning the suction line. It should be remembered that the area included between the suction and exhaust line represents negative work, therefore this area should be kept as small as possible. The above card is from a four-cycle engine.

Fig. 27 shows a card for the idle stroke of a hit-or-miss governed engine. The top line represents compression and the lower line expansion. If there are no leaks and the cylinder is not cooled too much, these lines should very nearly coincide. Any area between them represents lost work.

Fig. 28 is a card showing eight distinct explosions, none of which represents the best cycle. In the tallest cards, ignition was too early, in the middle two cards it was too late, and in the lowest cards it was very late.

Fig. 29 shows two explosions. The card with the high point represents a correct setting of the valves and mixture of the gases. The lower card was taken when the mixture was too rich in gas, showing that there was a loss of almost 25 per cent. in power by not having the proper mixture.

Fig. 30 shows one perfect explosion and five in which the ignition was too late.

Figs. 28, 29 and 30 are actual cards taken on an engine, while Fig. 26 is an ideal card with suction line exaggerated. Comparing the actual cards, it will be noted that the suction and exhaust lines do not show up. This shows the necessity of using light springs for determining setting of valves.

Fig. 31 shows a card in which pre-ignition occurred. From A to B is the suction stroke, while BC represents the beginning of the compression curve; at C, ignition occurred, and the pressure rose

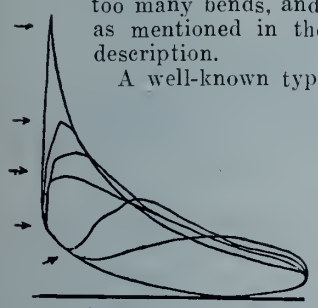


FIG. 30.

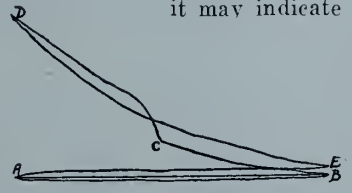


FIG. 31.

FIG. 32.

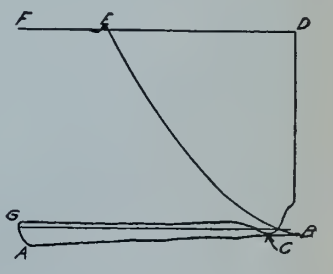


FIG. 33.

to the point D while the piston was still traveling forward. From D the gases expanded to E in the usual expansion curve. The card shows that very little useful work is delivered. Pre-ignition may be caused by using gas too rich in hydrogen which ignites without the application of a spark, due to the increase in heat while being compressed. It may also be caused by particles of carbon or other solid matter which are lodged in the cylinder and become incandescent under the temperature of compression, or when any of the water-cooled parts are insufficiently cooled, due to the use of too little water or water at too high a temperature.

Fig. 32 shows the type of card given when back-firing occurs. From A to B

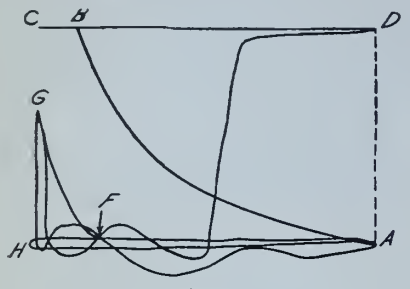


FIG. 34.

represents the ordinary suction stroke, but at F the gas was ignited before the suction stroke was completed, causing the pressure to rise to B. The partly consumed gases were then compressed up to D and expanded again practically along the same line. The result of a back fire is not only the loss of power in the stroke in question but usually causes a mis-fire on the next succeeding power stroke because an ignition takes place while the intake valve is still open, the burned gases go back into the intake pipe and foul the gases contained in it. This is shown by the idle stroke CE in the indicator card.

A back fire may be caused by badly timed ignition, by a leaky inlet valve, in which case the gas in the intake pipe is ignited during the previous explosion

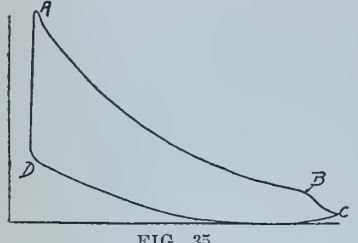


FIG. 35.

stroke, or it may be caused by using a gas of too lean a nature, so that the gas burns very slowly and continues to burn in exhaust stroke. A part of this gas is still burning in the clearance space when the next charge is drawn in. Again, if there are any pockets or small passages, the gas in the pocket may be cooled to a point where it does not ignite readily but becomes heated and ignites in the latter part of the expansion stroke and continues to burn until the succeeding suction stroke, when the incoming charge is ignited.

Fig. 33 shows a typical card taken with a Trill indicator having a one-half inch piston and an eight-pound spring. The line AB is the suction, and as this is only a trifle below the atmospheric line, it will be seen that the intake ports are ample and that no vacuum or negative pressure is produced. The line BE represents compression. This is not shown up to the limit of compression for the reason that the indicator is provided with a stop which limits the travel of the indicator piston and prevents damage to the instrument. Therefore, as soon as the pressure reached the point E, the pencil could not move any further and it traces a straight line to the end of the stroke at F. From F to D explosion and expansion of the gas have occurred, but as the pressures are still above the limit of the spring only a horizontal line is drawn. At D, however, the pressure falls to within the range of the indicator and the quick drop in pressure shown by the vertical line DC is proof that the burnt gases are being expelled from the cylinder without producing any back pressure. From C to G is the exhaust line, during which period the gases are expelled from the cylinder. As this line is only slightly above the atmospheric, little power is being lost. The card is practically a perfect one for a light spring, showing that all of the events occurred at the right time.

Fig. 34 shows a very bad card taken with a light spring and will also serve to show how valuable a good indicator is in detecting improper setting of valves, timing of explosions, etc. From H to A represents the suction stroke, and A to B the compression. It will be seen that the stop on the indicator is reached at B, and a horizontal line is traced to the end of the stroke. From C to D the pressures are above the range of the indicator. If the exhaust valve had been set properly, the line at D would have followed the dotted line similar to the straight vertical line shown in Fig. 33, but the exhaust valve did not open soon enough, therefore the pressure did not start to drop until nearly one-third of the exhaust stroke had been completed. Furthermore, the exhaust valve besides opening too late, closed too soon; this is shown by the rising pressure from F to G, indicating that instead of all of the burned gas being expelled, part of it was entrapped and compressed. This used gas mixed with the new charge fouls it Line GH shows that, as soon as the intake valve opened, this burned gas expanded back into the intake pipe, allowing the pressure to drop down to atmosphere.

All of the above cards not only represent a direct loss in power, but they also interfere with the operation of engines especially when they are direct connected to generators. Pre-ignition and missed strokes tend to slow down the engine, causing a variation in voltage of the generator which, if it is supplying a lighting current, introduces annoying flickering of the lights, or if the engines are direct connected to alternators which are running in parallel these momentary changes in angular velocity set up cross currents and introduce hunting between the generators.

It will thus be apparent that if maximum power and satisfactory operation

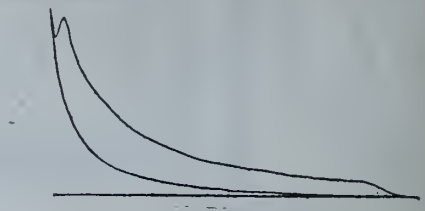


FIG. 36. POWER CARD.

are to be obtained from any gas engine it is absolutely necessary that it be indicated occasionally, for, even though the valves may be properly set when the engine is first set up, they are liable to become fouled and will stick, passages will become obstructed and other troubles will creep in unless they are periodically looked after.

The foregoing discussion applies mainly to engines working on the four-stroke cycle. Fig. 35 represents a typical card from a two-port, two-cycle engine. It will be noticed that the suc-

FIG. 37. SCAVENGING CARD.

tion and exhaust lines are absent in this card, the suction stroke being completed in an enclosed crank case or separate cylinder or pump. Point C represents the inlet of the mixture; CD is the compression line; D the point of ignition; DA represents the increase of pressure due to explosion; AB the expansion; at B the exhaust valve opens, and the line BC represents falling pressure due to exhaust. The card of the two-cycle engine would be modified practically the same as that of the four-cycle engine due to improper timing of the ignition valve events.

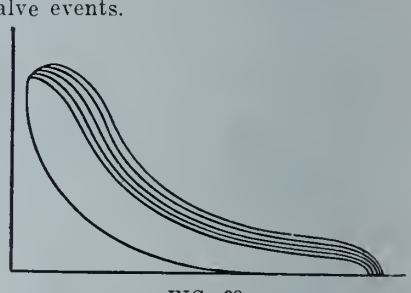


FIG. 28.

By taking indicator cards on gas engines it is possible to so time all the events that maximum power will be obtained. The mixture can be so regulated that maximum explosion pressure is obtained. The effects of different temperatures of jacket water can also be studied.

The horse-power of a single acting, single cylinder four-cycle gas engine is given by the following:—

$$\text{H. P.} = \frac{\text{PLAN.}}{4 \times 33{,}000}$$

Where P = mean effective pressure in lbs. per sq. inch = the mean ordinate of the indicator card × the scale of spring used; L = length of engine stroke in feet; A = area of piston in sq. inches; N = number of single strokes per minute = 2 × r.p.m. In the case of a hit or miss engine, N should be taken as the number of explosions per minute and the 4 omitted from the formula.

For single acting, single cylinder, two-cycle engines, the following formula should be use:

$$\text{H. P.} = \frac{\text{PLAN.}}{2 \times 33{,}000}$$

Figs. 36 and 37 are characteristic cards of one of the latest types of high compression, two cycle oil engines. These are actual cards taken on a Nordberg engine recently installed. Fig. 36 represents the power card, a 300 lbs. spring representing an m.e.p. of 75.5.

Fig. 37 is a scavenging card taken with a 10 lbs. spring, and represents the cycle of compression of the scavenging air on the crank side of the engine. This card gives the characteristics of the scavenging air compressed on the exhaust stroke and forced into the cylinder when the exhaust port opens. The purpose of this scavenging air is to remove the products of combustion and fill the cylinder with fresh air as quickly as possible. It is important that scavenging air valves and events be set and regulated by indicator card.

The diagrams Fig. 38 are characteristic of the modern type of Nordberg-Carels Diesel engine, and illustrate the result due to the variation of the governor adjustment, which varies the injection of the fuel.

Indicator Spring Data

Scale of Spring	Steam Pressures Recommended Not over 150 R.P.M.	Not over 300 R.P.M.
8	12	8
10	18	12
12	22	16
16	30	24
20	40	32
30	70	55
40	90	80
50	110	95
60	135	110
70	150	125
80	170	140
100	200	200
125	260	260
150	300	300
200	400	400

The above are conservative figures furnished by the Trill Indicator Co. They state, however, that they are willing to guarantee their instruments up to 600 r.p.m.

EXHAUST MUFFLERS FOR OIL ENGINES

IN a note on the operation of a small Diesel engine plant which recently appeared in the "Electrical World," a description is given of a method of muffling the exhaust of the engines. When the engines were placed in operation, the noise of the exhaust and the vibration it caused brought up an operating problem which required considerable study, and was worked out by the construction of special mufflers. The location of a deep well between the two units made it impossible to pipe the exhaust to one muffler, so that two were installed at opposite sides of the station. These were constructed of heavily reinforced concrete with a conical-shaped roof and steel stack projecting 3 ft. out of the top. They are about 8 ft. in outside diameter and 10 ft. high to the top of the concrete, and set on six concrete piles instead of solid foundation, to prevent vibration. The size of the mufflers was determined by the piston displacement and scavenger air volumes per stroke.

The exhaust enters at the bottom and on the side, where a circular brickwork makes the gases whirl about the centre of the muffler. This circular motion has a tendency "to pull a vacuum" behind the gases. On top of the brickwork forming the first stage is a system of grate bars, and on top of these are ordinary brick in layers which act as a baffle to release the exhaust gases gradually and reduce the noise. On top of this is a fine wire screen with a layer of crushed stone further to reduce the exhaust report. The conical-shaped top is merely to keep the rain out. Connection to the sewer is made to drain the condensation on the interior.

In order to keep the concrete from getting too hot when the engines are running continuously under heavy load, a ½ in. pipe is run out and tapped into the exhaust pipe just outside the muffler, and a small amount of water turned on. This water is carried into the muffler as steam, and keeps the temperature down. Frequently an accumulation of carbon in the muffler will catch fire. This is allowed to burn out for a while, or until the concrete begins to get too hot, and then water is turned on full in the small pipe to put the fire out. This process makes the muffler self-cleaning. The mufflers are so effective that the exhaust cannot be heard or any vibration of the air or ground felt when standing immediately beside them. When both engines are running, their intake exhausts about 4,000 cub. ft. of air per minute from the room.

After the installation was made, it was soon found to be practically impossible to keep the engine-room warm enough in winter. This was overcome by making a special air intake to the room, and at the same time utilising a portion of the waste heat of the exhaust. The iron exhaust pipe for one engine on the outside of the station was bricked in, leaving about a 6-in. space around the pipe and with the outer end of this brickwork open. The inner end of this brickwork opens into the floor of the engine-room right at the intake ports of the engine. The air is thus drawn in over the hot exhaust pipe, providing a source of hot air to produce a better mixture in the cylinder, and also overcoming the draught of warm air from the room. The exhaust pipe from the other engine is carried through the oil-tank room, and the whole room is used as an intake flue for the engine. Incidentally this heat in the oil-tank rooms keeps the oil in good condition in the coldest weather.

C. A. S. E AND GRADED CERTIFICATES

TWO meetings under the auspices of the Canadian Association of Stationary Engineers were held on January 29 in the Orange Hall, North James street, Hamilton, Ont. Both were of importance to members of the organization, and concerned the issuing of graded certificates to stationary engineers. The afternoon session was devoted to a joint conference, the individual constitution of which was as follows: W. G. Forbes, Montreal, president; John W. Hale, Hamilton, secretary; Robert Dyson, Guelph, past president; Rodger F. Gofton, Kitchener, vice-president; A. W. Heath, Hamilton, treasurer; William Cooke, Belleville, conductor; John W. Beasley, Chatham, doorkeeper; the Provincial Board of Stationary Engineers' Examiners, W. C. McGhie, Charles Mossley and Wm. Corrigan, also Dr. Ridell, superintendent, Trades and Labor Branch, Department of Public Works, all of Toronto. Hon. F. S. McDiarmid, Minister of Public Works, Province of Ontario, was unable to attend.

As a result of the deliberations, draft resolutions were framed regarding the grading of certificates and licenses for stationary engineers. These provide for four certificates according to qualification, namely, first, second and third class, also extra by virtue of merit. The decision arrived at will be duly forwarded to the Provincial Minister of Public Works, with a request that the Ontario Stationary Engineers' Act be so amended.

Dr. Ridell congratulated those present upon the intelligence displayed during the conference, and said, though the meeting was unanimous in the adoption of graded certificates, naturally it was to be expected that other districts would be adverse to the change. He thought some would disagree because of labor's reluctance to agree to a policy whereby a division would be made in the ranks, because some would say it savored of striking at the solidarity of labor. His view was that the grading tended for the men's greater efficiency and better collective bargaining. He also thought there was a better time in store for labor after the war, for the second industrial evolution in England was bound to react in Canada in th enear future. "If we can read the signs of the times, shorter hours, higher wages, and better conditions are inevitable for labor, for the workers of the land will be more efficiently trained, and consequently labor must benefit," he said. Concluding, the speaker said he couldn't say that graded certificates would be concurred in by the Government, but he could say that if the engineers of Ontario wanted it, they could get legislation if they went the right way about it. If adopted, the Government would make the scheme self-sustaining.

Question and Answer Section

Heating System Back Pressure.—When extracting steam from a turbine, what is the economical limit to back pressure in the heating system?—N. E. A.

The economical limit depends entirely on the design of the turbine and the local conditions under which it is operating. Bleeder turbines may be designed for most economical performance when bleeding at almost any given pressure. With a suitably designed turbine and favorable operating conditions, it would be economical to extract steam at pressures up to within roughly 25 per cent. of the throttle pressure.

* * *

Live Steam in Heating System.—When would it be economical to use live steam in a heating system, rather than bleed the turbine?—N. E. A.

It would be preferable to use live steam in a heating system rather than bleed from the turbine, except when the design of the turbine and the conditions under which it operates are such that when bleeding direct from the boilers and operating the turbine straight condensing, the total amount of steam used will not exceed that required by the turbine when operating as a bleeder.

* * *

Boiler Horse-Power.—I should like to have you explain by what means the horse-power of steam boilers is determined?—T. W.

A somewhat similar question was asked and answered in our issue of September, 1916—Question and Answer Section—the only difference being that tractor boilers, flue boilers, and water-tube boilers were specifically referred to. The information then furnished meets the present query fully, and is reproduced as follows:—Boiler horse-power, it may be stated at the outset, is a misnomer, and should be reckoned as simply a convenient and compact means of making comparison of boiler capacities for commercial purposes. A boiler, no matter its classification, form or type, be it horizontal or vertical, smoke-tube or water-tube, internally or externally fired, designed and constructed for high, medium or low pressure, and be it installed ashore or aboard ship, is essentially a vessel in which steam is generated. The power is in the steam, and little exemplification of that power is to be had as far as the boiler is concerned except when the latter blows up, and we have what is known as a boiler explosion of lesser or greater magnitude. On this continent the accepted commercial rating of one boiler horse-power is taken to represent an evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees Fah. into steam at 70 pounds gauge pressure, this being considered as equal to the evaporation of 34½ pounds of water from a temperature of feed water of 212 degrees Fah. (boiling point of water) into steam at the same temperature. Further, a boiler rated at a given horse-power is expected to demonstrate same with easy firing, moderate draught, with ordinary fuel, and to show at least a fair measure of economy. Again, the boiler should be capable of developing from one-fourth to one-third in excess of its rated power if called upon in an emergency. Tractor, flue, water-tube, or for that matter any classification of boiler come under this commercial horse-power rating if their manufacturer so will it, at the same time there is nothing compulsory about acceptance being all inclusive, in which circumstance a boiler-maker may adopt a rating to suit himself and that of his clients. The boiler generates steam, the engine develops the power, and the principal concern is in our seeing to it that the boiler capacity for steam generation is ample for the duty that the engine has to perform, and that the greatest economy of fuel is being realized. Rough-and-ready rules for computing boiler ratings may be taken as 12 sq. ft. of heating surface, or one-third sq. ft. of grate area per boiler horse-power respectively.

* * *

Drying Out A. C. Generator.—In the Question and Answer Section of your November issue, methods of satisfactorily drying out direct current generators were among other things specially featured. What method should be employed for drying out an alternating current generator and a synchronous motor respectively.—G. E. R.

A generator may be dried out simply by driving the rotor at normal speed for several days by its prime mover. However, if excitation is applied in addition, the process will be accelerated. In this case, a generator of less than 6600 terminal volts should be run at normal speed with the armature windings short circuited and with a belt excitation sufficient to give approximately 110 per cent. normal current in the armature windings. For a generator of 6600 terminal volts or more, it is recommended that the drying-out process be conducted by alternate runs with the armature windings short circuited (and excited as previously described) and the windings open circuited (and excited to give approximately 110 per cent. normal voltage. The former dries the insulation from the inside outward, and the latter the reverse. This alteration should be kept up until the insulation resistance, as measured by a megger, becomes fairly constant. An empirical rule which has proved very satisfactory is that the insulation resistance of the armature windings should be approximately equal to three times the terminal voltage by the kilovolt-ampere rating. For example, assume a 10,000-kv-a., 6600-volt generator, then the insulation resistance should be approximately

$$\frac{3 \times 6600}{10{,}000} = 1.98 \text{ megohms.}$$

While this applies to the armature windings only, it may be used as an indication of the completion of the drying out process, for stator and rotor windings are dried at the same time.

For drying out a synchronous motor, the methods described for alternating-current generators cannot, generally speaking, be applied to synchronous motors and frequency changers. If a source of direct current is available, the field and armature windings may be connected in series or parallel depending on the machine and current passed through, until a temperature of approximately 65 deg. C by thermometer is reached. This should be continued until the insulation resistance by megger attains the value designated in the alternator query reply, or until it becomes constant. Another method is to dry out the machine by an application of external heat. For the source of heat, an oven may be used, or a number of coils of steam pipe, which with the motor are to be enclosed in a box. Openings in the top and bottom of the box should be provided to give circulation, the moisture being carried off by the hot air.

* * *

Boiler Horse-Power.—To settle a bet, will you kindly calculate the horse-power of a horizontal return tubular boiler, the mean diameter of which is 5 ft. and the length 14 ft. There are ninety 3-inch smoke tubes?—R. K.

The total heating surface may be reckoned as consisting of the lower half of the boiler shell plus the surface of the tubes, and this divided by 10-12 or 15, being representative of sq. ft. of heating surface per boiler horse-power in more or less common use, will give a variety of ratings, on the middle one of which a mutual agreement may be come to, and the bet be called off. The details

of the calculation are given below. It will do no harm, however, if the bettors read carefully the reply given the boiler horse-power query of T. W. in this same issue.

Heating surface of lower half of boiler shell $= \frac{5 \times 3.1416}{2} \times 14 = 109.95$ sq. ft.

Heating surface of ninety 3-inch tubes, each 14 ft. long $= 90 \times \frac{3 \times 3.1416 \times 14}{12}$ $= 989.60$ sq. ft.

Boiler shell heating surface plus tube heating surface $= 109.95 + 989.60 = 1099.55$ sq. ft. total heating surface.

Total heating surface divided by 10-12 and 15, give boiler horse-power respectively of 109.95, 91.63, and 73.3.

* * *

Boiler Quivering Under Steam.—We have a 60-inch diameter by 14 ft. long return tubular boiler, without dome, which supplies steam to a horizontal Corliss engine whose cylinder is 16-inches in diameter by 30-inches stroke. The engine load averages about 100 horse power. After running about two hours in the morning, the boiler begins to quiver and continues to jump so to speak, during the rest of the day, but to a greater degree when a fresh fire is put in. I have asked several engineers for an expression of opinion as to the cause of the quivering but have been unable to secure a satisfactory explanation so far. I shall be glad to have you give me a reason for this peculiar and altogether startling phenomenon, accompanied by a suggestion or suggestions as to how the uncanny display may be brought to a close.—C.M.C.

The fact that the trouble gets worse when fresh fires are put on would point to it being due in some way to boiler conditions. The steam consumption of an engine of this type running non-condensing would be well over 20 lbs. per hour, which with possible condensation losses in piping would approach 30 lbs. of steam per hour. As a boiler of the size and type mentioned would have a normal capacity of about 60 boiler horse power i.e. 30 lbs. of water per horse power, it may quite well be running much over capacity. The absence of a steam dome, along with impure water and a heavy deposit of scale would cause sufficient priming to give rise to the quivering mentioned especially if the steam pipe have sharp bends near the engine and no separator is fitted: the quick cut-off of the Corliss gear would cause vibration through the sudden stoppage of the flow of steam which would be still worse if the steam pipe is of too small a diameter. The increased vibration after firing up is probably due to increased priming resulting from the drop in pressure while the fresh fire is burning up.

To remedy the present conditions, the water should be treated to insure a proper degree of purity, the steam pipes should be covered with the best material available, and a receiver separator installed close to the engine. Sharp bends or elbows should be made easy and if possible an expansion bend put in the steam pipe near the boiler. These are mentioned as meantime remedies short of an actual increase in boiler plant capacity.

* * *

Belt Lengths.—It occurs to me that I may at some time or another be called upon to order the necessary belting for either an open or crossed drive, and, in order to be prepared for such eventualities, how may I arrive at their exact length?—T. W.

On all ordinary open belt drives, such as are found in machine shops, the required length of belt can be calculated with sufficient accuracy by adding half the diameter of one pulley to half the diameter of the other, both in inches, multiplying this by 3 1-7 and dividing by 12 to bring the result to feet. Now add to this twice the distance between centres, with an extra allowance of, say, 1 in. for each 10 feet of belt, where width is from 2 in. to 4 in. Belts less than 2 in. wide can do with a less allowance, while belts over 4 in. require 1½ in. to 2 in. allowance. Such a method would give accurate enough results for pulleys up to, say, 20 ft. apart, and of approximately equal diameters. In cases where there is a great difference in the diameters of the pulleys additional allowance must be made, also when the shafts are far apart, the amount necessary to provide for sag may be considerable. Where crossed belts are used, the length of the straight parts between the pulleys may be calculated approximately by adding the square of the large pulley diameter to the square of the distance between centres, and taking the square root of the result, which will give a safe length for one of the diagonal lengths. In ordering belting, as in many other supplies, it is best to be on the safe side, and in many shops a roll of belting of each size is kept in stock. If drives are important enough to demand special belts, a steel tape and a capable millwright offer the quickest and most accurate results in measuring.

* * *

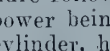
Steam Engine Horse-Power.—What is the usual procedure followed in figuring out the horsepower being developed by, say, a single cylinder, horizontal or vertical type steam engine, and what additional calculations are required in the case of an engine having two or more cylinders; a compound or triple expansion engine, for instance.—T. W.

In order to calculate the horse-power which is being developed by a particular engine, it is necessary to know the mean effective pressure which is exerted on the piston throughout the length of its stroke. This is obtained from the indicator diagrams which are taken from each end of the cylinder during a number of strokes to get an average diagram. Diagrams should be taken from both ends simultaneously if accurate results are required, as the loss of area on one side of the piston due to the piston rod, makes an appreciable difference in the results. Assuming that cards are taken from each end, the average height of the diagram in inches is found in the usual manner, which, when multiplied by the strength of the spring used, gives the mean effective pressure or m.e.p.

The "plan" formula is the most easily remembered method of figuring the power. It is as follows:—

$\frac{\text{PLAN}}{33{,}000}$ = indicated horse-power where P is the mean effective pressure in lbs. per sq. in., L is the stroke in feet, A is the area of the piston on which the pressure acts, and N is the number of times per minute that the pressure is exerted on the piston. In the case of a single cylinder engine 12 in. dia. x 18 in. stroke, running at 120 revs. per min., the front end card may have given a m.e.p. of 65 lbs. per sq. in., and the rear end, 70 lbs. per sq. in. With a piston rod diameter of 2 in., the power developed in the front end would be, 65 × stroke in feet, 1½ × area, 113.1 — 3.14 × number of revolutions per min., 120, all to be divided by 33,000, thus $65 \times 1\frac{1}{2} \times 109.96 \times 120 = 1{,}286{,}532$, which, divided by 33,000 = 38.9. The power developed in the rear end differs to the extent of the piston rod area which is not deducted, thus $65 \times 1\frac{1}{2} \times 113.1 \times 120 = 1{,}323{,}270$, which, divided by 33,000 = 40. Adding the two ends together gives $40 + 38.9 \div 2 = 39.45$ I.H.P. In the case of the front end, 3.14 is the area of the 2 in. dia. piston rod, which is deducted from the total area of the 12 in. piston. Where a tail rod of equal diameter to the piston rod is used, the effective areas on either side of the piston are the same, and if the m.e.p. on each end is equal, the power can be found in one calculation by using twice the number of revolutions, which is the number of times the power is exerted on the shaft in one minute.

In the engines having two or more cylinders, the additional calculations apart from the m.e.p. which is found from the diagrams, would be the figuring of the piston diameters, which would be increased as the absolute steam pressure dropped in each cylinder, the stroke of each cylinder being the same.



FAILURE of material owing to it being unable to withstand the action of a suddenly applied shock is quite frequently met with. The importance of testing the capability of the material to the resistance of shock stresses is not yet fully recognized by engineers and machine designers. It is well worth the trouble to make an approximate analysis of the different stresses that are applied to the steel parts of any particular machine. It will be found that in nine-tenths of the machines in use fully 50 per cent. of the stresses are due to constant shock, and at least a further 25 per cent. are due to intermittent shock. Therefore, if 75 per cent. of the stresses applied to steel parts are due to shock, it is obviously essential that some form of shock or impact test should be applied.

Steam Power Plant Auxiliaries

STEAM SEPARATORS—1.

WET steam is probably the most troublesome feature of steam power plant operation with which engineers have to contend. Not only is it dangerous through giving rise to water hammer with breakdowns and occasional loss of life, but all the time it is a source of continual loss in the efficiency at which a plant operates. Even though the steam as it leaves the boiler is comparatively free from moisture, it has been found as a result of investigations that about 3 per cent. of water is nearly always present in the steam as it enters the engine, and that in some cases it may exceed 50 per cent., part of this being water carried over from the boiler and part due to condensation.

Causes of Wet Steam

Various conditions are responsible for the presence of water in steam, chief of these being priming of the boiler, and excessive condensation in the pipe line. In the case of the boiler, a small percentage of water is always present in the steam unless the rate of evaporation is extremely low; rapid steaming boilers being much more prone to priming than the less modern cylindrical types with or without tubes, although any sudden reduction of pressure is liable to cause priming despite the provision of large steam-liberating surface and water-carrying capacity. In any case, a proportion of solid water may enter the pipe line along with the steam, forming a slug, which is carried along with the steam at a high velocity until it reaches the engine after which something unfortunate is liable to happen.

Under normal conditions, an uncovered steam pipe will condense fully three-quarters of a pound of steam per hour for each square foot of surface. Properly covered pipes reduce this to a great extent but are unable to prevent a degree of condensation sufficient to saturate the steam so that a serious loss of efficiency is unavoidable in any engine working under these conditions, unless the moisture and water be almost entirely removed from the steam. Even where the principle on which a separator works may not be quite correct, its value is frequently increased by the provision of a receiver of suitable volume which not only gives the moisture an opportunity to settle by gravity, but also cushions the pulsations of the steam in the pipe caused by the opening and closing of the valve in the engine cylinder.

Necessity for Separators

The detrimental effect of wet steam on cylinder lubrication in piston engines, and on the blades of steam turbines has been proven frequently and

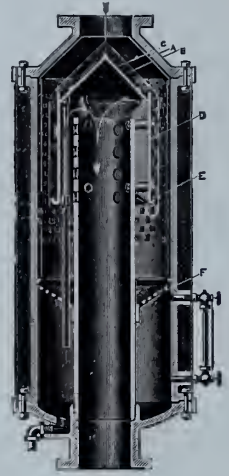


FIG. 1. VERTICAL STYLE SWEET'S SEPARATOR.

the economy of oil and upkeep in both types of prime movers is sufficient in many cases to justify the installation of a steam separator. When to these features is added that of freedom from breakdown due to water hammer, the vital necessity of an efficient steam

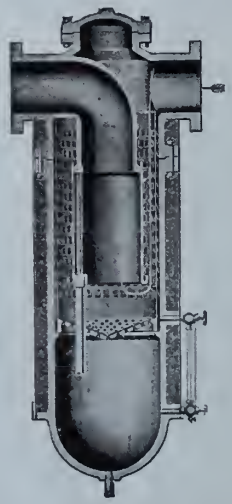


FIG. 2. HORIZONTAL STYLE SWEET'S SEPARATOR.

separator becomes more and more apparent.

The recognized standard of efficiency for a steam separator is the ability to separate not less than 99.5 per cent. of moisture from steam depending upon circumstances, good modern practice enabling higher results to be obtained. Other features deserving consideration are, the minimum reduction of pressure in currents passing through the separator, simplicity and durability of construction, compactness, and suitability for operation under high pressures.

Sweet's Separator

The design of this separator is based on the fact that water may be removed from steam by passing the steam over a corrugated or rough surface, to which the little particles of water adhere. The surface employed is broken up in such a manner that the little particles are immediately conducted out of the steam current, and kept from further contact with it. The capillary principle, which is the foundation of the design, is most efficiently employed when the surface is at a maximum, and the various types of Sweet's Separator, as built by the Direct Separator Co., Syracuse, N.Y., are provided with liberal separating surface and large space for steam storage and water chamber, the latter feature making it of value as a steam receiver to prevent vibration etc.

The vertical type is illustrated in Fig. 1. The accumulated moisture around the walls of the steam pipe is caught by the upper edge of cone A and carried down back of a lining to the water chamber. The current of steam entering the separator impinges upon the conical surface composed of solid plate C covered with sieve B, through which water may freely pass, but from which it cannot readily escape. Passing through the sieve and depositing on the solid surface of the cone C this water is carried by conductors to the water chambers. By means of the cone the column of steam is changed to an annular ring, which is comparatively thin even while the full area of the pipe is maintained. The steam upon the outside of this ring comes in contact with the lining of the shell, which is a sieve of the same character as at B, and which catches and entrains any water which may be contained in that portion of the current. There is also provided a trough at lower edge of inverted cup, which leads all the water that may adhere to its surface down to the conductors to the water chamber. The current of steam passes through the passages in-

dicated by the white lines, and is subjected to a whip-snapping action which will throw off any moisture that has not been caught by the surface over which it has passed. The diaphragm F pre-

FIG 3. WEBSTER VERTICAL SEPARATOR SHOWING BAFFLES AND GROOVES.

ents the steam from picking any water ut of the water chamber.

The horizontal separator, Fig. 2, perates in substantially the same manner as the vertical style, the moisture n the bottom of the inlet pipe being aught by the shelf and cone provided,

G. 5. HOPPES VERTICAL SEPARATOR, SHOWING CONE AND INTERCEPTING TROUGHS.

om which it finds its way to the back the lining and to the water chamber e moisture adhering to the elbow passes over its surface and is caught by the trough provided, whence it passes through conductors to the water space. The steam then passes in an annular ring through the space indicated by white lines and is acted upon the same as in the vertical style.

In the smaller sizes, the separating plates are made of copper, and in the larger sizes a special non-corrosive sheet iron is used. The smallest size made weighs 50 lbs., and the largest 24,000 lbs.

Webster Separators

Eleven different styles of these separators are built by Darling Bros., Montreal, the wide variety enabling piping and pressure conditions to be conveniently met in installations of all kinds. The standard types are also modified to form receiver separators which provide receiver wells of unusual dimensions to receive large slugs of water from excessive boiler priming or unusual condensation in low-pressure service and also tend to equalize steam pressures at the point of delivery because of the large quantities of steam which they store.

Cast iron shells are used in all of the standard types, of which the vertical and horizontal designs are illustrated in Figs. 3 and 4 respectively. In the former, the steam is directed into a central space which reduces the velocity considerably to assist in separation, the cast iron baffles which extend across this space causing a sudden change of direction of flow with consequent freeing of entrained moisture. The upper walls of the central space are provided with sloping grooves which complete the process of separation as the steam passes over them on its way to the outlet at the lower end.

The horizontal separator, Fig. 4, is provided with a central baffle plate with collecting ribs on the face against which the steam impinges, the moisture dropping from the ribs into the collecting space below. The lower ends of the ribs are connected to a diaphragm which prevents free passage of the of the steam below the baffle, suitable spaces around the sides and top being provided for the passage of the steam.

Hoppes Separator

This apparatus has been designed on the principle of reduced steam velocity with a complete absence of tortuous passages, baffles, abrupt reversals of direction etc. To accomplish this object the inlet passage is gradually enlarged into the expanding chamber where the water is deposited, being then gradually reduced to the capacity of the steam

FIG. 4. HORIZONTAL TYPE OF WEBSTER SEPARATOR WITH VERTICAL RIBBED BAFFLE.

pipe; the working areas nowhere are less than three and one-half times the area of the pipe.

The vertical type is shown in Fig. 5 from which it will be seen that no obstructions to the free flow of the steam are offered, nor are there any edges

FIG. 6. HOPPES HORIZONTAL SEPARATOR WITH SEPARATE TROUGHS TO EACH PASSAGE.

from which the water of entrainment can be blown off and atomized. The entrainment follows the surface to the

lowest part where it is intercepted by water in the bottom. Water which strikes the cone on entering is also collected in a trough, partly filled with water, being then carried to the bottom by the pipe shown. The dry steam

FIG. 7. SMART-TURNER SEPARATOR WITH CENTRE BAFFLE AND GROOVED WALLS.

escapes through the upper end of the outlet pipe which projects up underneath the cone.

The horizontal separator Fig. 6, is so designed that the steam may flow through it in either direction. The inlet and outlet ports are separated by a vertical division plate which extends down to where separate gutters surround the inlet and outlet passages. These are partly filled with water to intercept all water of entrainment fol-

FIG. 8. HORIZONTAL STRONG SEPARATOR SHOWING LIP FOR TRAPPING CONDENSATION.

lowing the surface, while the downward plunge of the steam entering the steam chamber throws the water of saturation to the bottom of the separator. The excess water is carried from the troughs by pipes to the bottom of the separators from which it is trapped in the usual way.

These separators are built by the Hoppes Mfg. Co., Springfield, O., in sizes from 1 in. to 9 in. inclusive and suitable for working pressures of 200 lbs. per sq. in.

Smart-Turner Separator

This apparatus is of the impact baffle type, in which change of direction along with collecting surfaces is relied upon to extract the contained moisture. It is of the horizontal type, suited for use in either direction (see Fig. 7). The steam inlet opens directly into an expansion space, in which is placed a ribbed baffle plate, supported on a gutter-shaped divi-

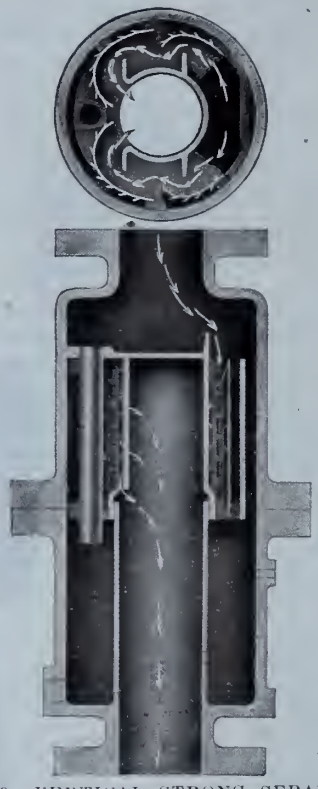


FIG. 9. VERTICAL STRONG SEPARATOR WITH LIP ON TOP AND DRAIN PIPE TO WELL.

sion plate extending across the space. After impinging on the baffle and depositing moisture, the steam passes over and around, thus coming in contact with a suspended baffle on top, and numerous vertical ribs or grooves formed on the side walls in such a way as to carry the collected moisture down past the division plate into the collecting well, from whence it is drained by trap in the usual way.

These separators are built by the Smart-Turner Machine Co., Hamilton, Ont., in sizes from 2 in. to 12 in.

Strong Separators

The horizontal and vertical types of this device are shown in Figs. 8 and 9, special attention having been given to providing means for removing the water of condensation, which in the case of long horizontal pipes sometimes assumes a large volume running along the bottom of the pipe. The separator is, therefore, so constructed that it does not throw together the condensed steam and entrained moisture. As shown in Fig. 8, the stream of water is caught by a projection from the cage, and is at once conveyed to the well without being mixed with the steam. The entrained water

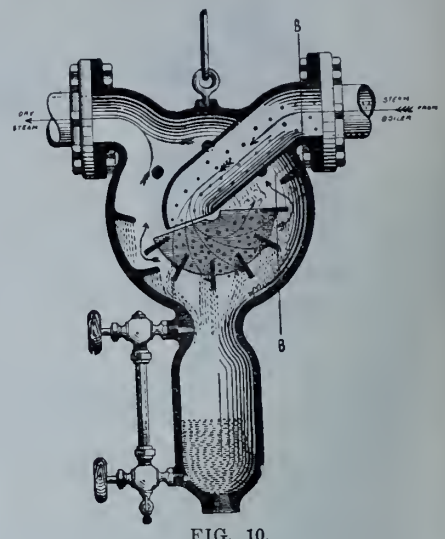


FIG. 10.

goes with the steam around the inner pipe, and is thrown by centrifugal force against the surrounding perforated copper sheet, through which it can readily pass, but through which it cannot return.

In passing around the inner pipe, the shape of the current of steam is changed from a circular to a narrow rectangular one, and is also subjected to a whip-snapping action, which throws off any moisture left in the steam. A metal ring at the bottom of the separating cage prevents the steam from picking up any water from the water chamber.

In the vertical type, Fig. 9, the water coming in with the steam is caught in the upper chamber and carried by the pipe shown to the water chamber, the remaining action being the same as in the horizontal type. These separators are built by the Strong, Carlisle & Hammond Co., Cleveland, O., in sizes from 3 in. to 12 in., both types being built in two sections, the lower one acting simply as a water collecting chamber. When a receiver type of separator is desired, it is furnished of any required dimensions by enlarging the water chamber.

W. & McD. Combine Separator

In these separators, use has been made of four methods of separation; viz., expansion, reverse of current, centrifugal force and baffle plates. These accepted mediums are combined in a suitable manner so as to give desired results in separating entrained water from steam. The steam enters as shown, the increased volume of the chamber reducing the velocity so that the heavier particles fall out by gravity.

By placing the mouth of the inlet pipe in the position shown, the steam is caused to reverse its current, and also assume a whirling movement, the separating effect of which is further enhanced by a series of baffle plates placed in a circular position radiating toward the

centre in the path of the steam. These form an obstructing surface for all non-elastic substances to impinge against and be precipitated to the well of the separator for removal by trap.

These separators are built by Watson & McDaniel Co., Philadelphia, in sizes from 2 in. to 9 in. for a working pressure of 125 lbs. per sq. in., in cast iron. Sizes from 10 in. to 20 in. are built entirely of steel plate.

CHIMNEY AND MECHANICAL DRAUGHT

IN the course of a paper read before the recent annual convention of the American Smoke Prevention Association, E. R. Fish stated that boiler and furnace practice had changed to such an extent that the generally accepted ideas of a few years ago were now largely obsolete. Most large and many small plants were now equipped with mechanical stokers of some one of the numerous types, particularly in those centres where room was limited and smoke abatement laws were enforced. While chimneys alone were still largely depended upon to produce the draught necessary for the combustion of fuel, the tendency was strongly towards supplementing them with mechanical equipment. The effective draught, or that which was used for getting the air through the fuel bed, might be produced in three general ways: First, by the natural draught of the simple chimney; second, by induced draught; third, by forced draught; yet, when the whole of the boiler installation was considered, several combinations of these might be desirable or necessary.

Natural Draught Intensity

Where natural draught alone is depended upon, it must be of sufficient intensity to overcome all the resistances from the top of the stack to the ashpit door. With a given height of stack the available draught was practically fixed, although it varied with the temperature, state of the weather, barometer, etc. A chimney of moderate height could not supply a sufficient draught to maintain what was now looked upon as a high rate of combustion. For conditions under its maximum, natural draught was easily controllable by means of dampers so that the furnace conditions could be maintained at the most economical point. The principal recommendations of a chimney were its simplicity of operation, its need for comparatively little care and attention, and its being always on the job. Its thermal efficacy was low, but the other advantages offset that in cases where high draught intensity was not needed.

To attain a strong draught by means of a chimney was prohibitive because of the great height involved and the cost. It was therefore necessary to turn to other arrangements, such as an induced-draught system, wherein the suction was created by a fan. The nature of this draught was exactly the same as chimney draught, but it had the advantage of being susceptible to accurate control so that the furnace needs might be readily met. It made possible the installation of economizers to lower the temperature of the escaping gases and effected a saving in fuel.

Combination Feature

At the present time a combination of forced draught and either natural or induced draught was being used more and more. Many of the later stokers were operative only with forced draught and were designed for high rates of combustion. Forced draught alone was not a good arrangement for the reason that it created a plenum throughout practically the whole installation and made leaks outwardly through the interstices in the setting likely. By providing a stack of proper height or an induced-draught fan the necessary suction draught might be supplied to overcome the resistance of the gas passages, leaving the forced-draught fan to supply the pressure necessary to overcome the resistance of the fuel bed. This produced that desirable condition, balanced draught, the pressure above the fuel bed being practically zero or preferably a little on the minus side, namely, the draught gauge should show a slight vacuum.

The amount of fuel burned under a boiler largely determined the amount of steam that would be generated. There was, of course, a more or less well-defined relation between grate area and heating surface, although this varied between rather wide limits. The heating surface of boilers in many instances was being worked far harder than was supposed possible a few years ago. This had been brought about by the introduction of furnaces capable of high rates of combustion, with the result that the temperatures of the escaping gases was too high for the proper economy, rendering necessary the use of feed-water economizers of proper capacity.

The need for a high intensity of suction draught in connection with forced draught, when high capacities were used, was not generally recognized. When it was realized that the draught required to cause the flow of gas increased as the square of the velocity, it would be seen that this was important. If ½ in. in the uptake was sufficient for satisfactory operation at one capacity, doubling the capacity at least doubled the quantity of gas, which meant that the gases must flow twice as fast, assuming that the furnace efficiencies and temperatures were the same in both cases. Theoretically, therefore, it would take four times as much draught, or 2 in., as measured by the water column. It was on this rock that many engineers had come to grief in that the attainment of their desire to get a high capacity out of their boilers had not been possible, because after reaching a certain rate of combustion, there was a plenum created in the furnace and through the setting, resulting in furnace gases coming out through the numerous interstices owing to the insufficiency of the available suction draught to pull the gases through the boiler and breeching.

The balanced condition was highly advantageous in another way. The greater the difference in pressure between the inside of the setting and the outside, the greater the amount of air drawn in through any cracks or openings, as well as through the porous setting. The less these differences in pressure the less air would be drawn through. All such air was only detrimental and could do no possible good. Every effort should be made to prevent these leakages if the boiler plant was to be run at its highest efficiency.

The attempt to force a grate to burn more fuel than the draught available inevitably resulted in waste and inefficiency through the formation of carbon monoxide instead of carbon dioxide, so that where draught could not be increased beyond a certain point, care must be used not to force a higher rate of combustion than could be efficiently maintained. Every set of boiler and furnace conditions had its most economical point of operation, which could not be exceeded with satisfactory results, but this was true within much narrower limits of simple chimney draught than with either forced or induced draught with the accompanying possibility of widely varying adjustments.

Tendency of Modern Boiler Practice.

The tendency of modern boiler practice was decidedly toward setting boilers well above the grates so as to give a large combustion space. It was pretty generally recognized that the heat of combustion should all be freed before any of the gases came in contact with the heating surface of the boilers, which, in relation to the gases, was the cooling surface. A large, high furnace and combustion chamber was essential to attain this end, in addition to which the resistance to flow was minimised.

It was important that the breeching should be as short and direct as possible. Square turns of any sort should be avoided, as all such increased the resistance. The well known principles governing the flow of water applied almost as universally to the flow of gases. Easy curves should be provided and all corners and dead spaces avoided. Areas must be properly proportioned to the volume of gases to be cared for, and this was particularly true in those plants where high overload capacities were contemplated.

Modern boiler practice seemed to indicate that for the larger and more important plants, at least, something more than ordinary chimney draught was needed. Where simplicity of installation was paramount, simple chimney draught could not be improved upon. As applying to the average plant throughout the country, every means should be used to prevent air from entering the gas passages other than through the fuel bed, and that the loss of draught due to restricted, improperly designed, and obstructed flues be reduced to a minimum, so that the boiler and furnace would be in condition to give the maximum efficiency.

Progress in New Equipment

SINGLE AND MULTI-STAGE STEAM TURBINES

THE merits of the combination type of steam turbine have met with constantly increasing recognition during the past few years, and the turbine shown herewith has been developed to meet the demand for turbines of that type in sizes from 5 to 1000 horse-power.

The Moore steam turbine is built by the Moore Steam Turbine Corporation, Wellsville, N.Y., in both single-stage and multi-stage designs, the former consisting of a single velocity stage made up of a set of diverging expanding nozzles and a wheel carrying two rows of moving blades, with a set of stationary reversing vanes following the first row of moving blades.

Figs. 2 and 3 are sectional drawings of the single and multi-stage turbines respectively from which it will be observed that the multi-stage turbine consists of the same single turbine, followed by two or more single pressure stages. Each of these single stages consists of a set of nozzles and a wheel. This form of turbine has given very efficient results in large size units, but has not hitherto been built in small sizes because of its rather high cost of construction. To overcome this difficulty, the Moore steam turbine has been so designed and standardized that the different parts can be produced on a quantity production basis; all standard parts are made for stock which enables rapid assembly and shipment of standard machines and also facilitates the supply of spare parts with consequent saving of time in repair.

In order to avoid possible trouble resulting from excessive speeds the designers of these machines have limited the speeds of the larger sizes to 3,600 revs. per min. and of the smaller sizes to 5,000 revs. per min. as a maximum, the required steam consumption being obtained by multi-staging when necessary. By this means the rotation stresses are kept at a low figure with a larger margin of safety. A benefit obtained from the use of a velocity stage for the first stage is, that on account of the comparatively large drop in pressure in the first stage, there is less difficulty in packing the shaft against leakage at the high pressure end of the turbine.

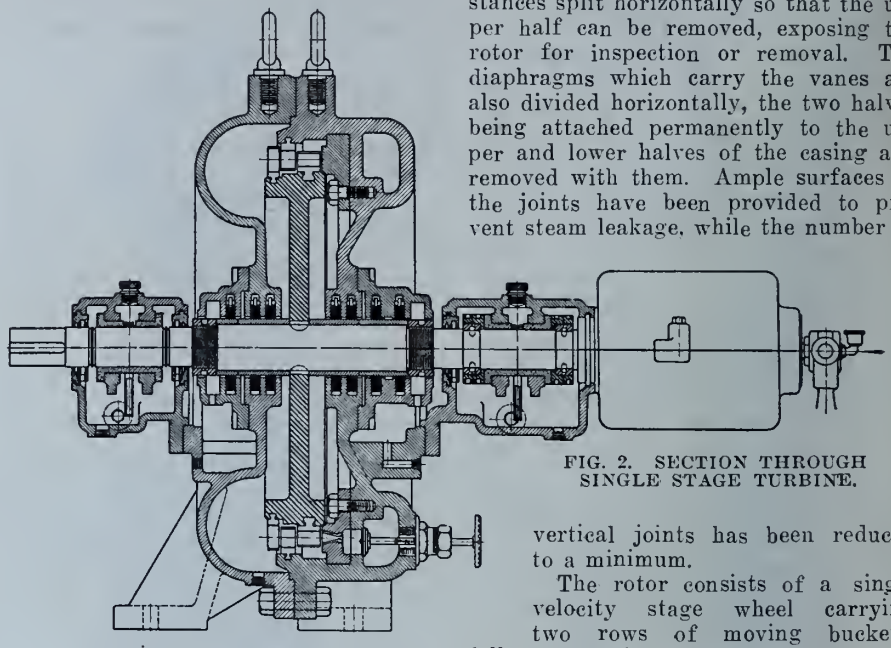


FIG. 2. SECTION THROUGH SINGLE STAGE TURBINE.

The turbine casings are in all instances split horizontally so that the upper half can be removed, exposing the rotor for inspection or removal. The diaphragms which carry the vanes are also divided horizontally, the two halves being attached permanently to the upper and lower halves of the casing and removed with them. Ample surfaces at the joints have been provided to prevent steam leakage, while the number of vertical joints has been reduced to a minimum.

The rotor consists of a single velocity stage wheel carrying two rows of moving buckets, followed by the pressure stage wheels, all mounted on the same shaft.

Drawn steel buckets are set into a dovetailed groove in the periphery of the wheel, being easily removed when renewal is necessary. Liberal clearance (½ in.) is allowed over the ends of the buckets, while the endwise clearance is so arranged that the side of the wheel and not the buckets will rub, should the rotor be displaced lengthwise. The nozzles in the first stage are of the diverging, expanding type and are made of bronze, cast and finished accurately to size, and then recast into a cast iron ring which is attached to the steam end casting. The nozzles of the second and following stages are formed by casting sheet metal strips into the diaphragms, being afterwards broached out to gauge to the size required; this method of manufacture gives a perfectly smooth and highly efficient nozzle.

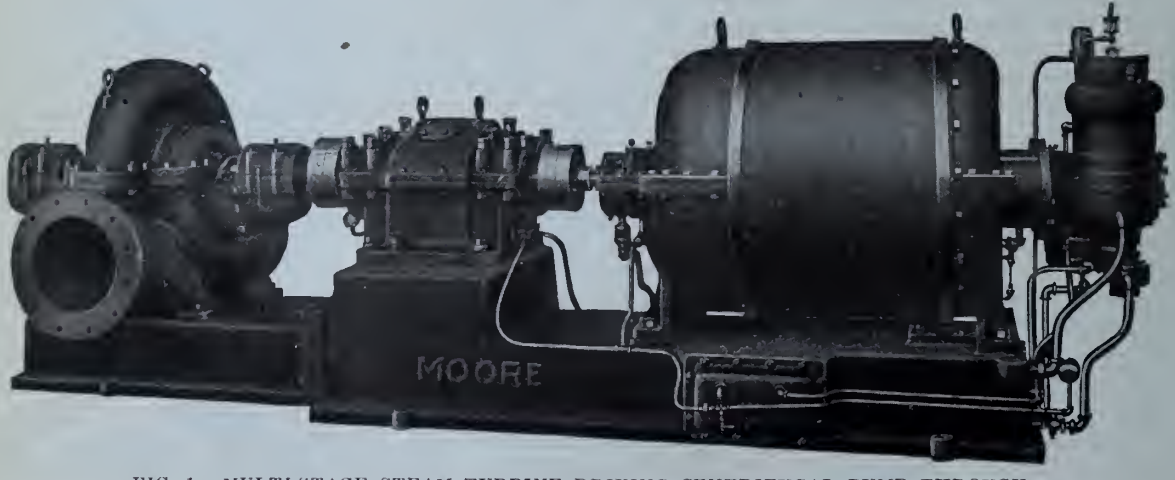
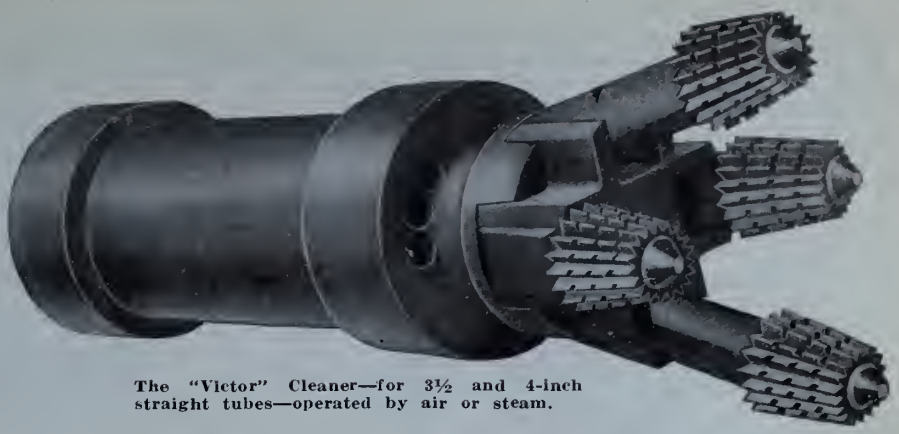


FIG. 1. MULTI-STAGE STEAM TURBINE DRIVING CENTRIFUGAL PUMP THROUGH DOUBLE HELICAL REDUCTION GEARS.



The "Victor" Cleaner—for 3½ and 4-inch straight tubes—operated by air or steam.

THE VICTOR

"The longer it runs, the better it works"

This is what Mr. Christensen, Chief Engineer of the Des Moines Electric Company, said when speaking of a test made in his plant between the Liberty, "Victor" Tube Cleaner and a "best" cleaner of another make. He had purchased both machines, and the test was simply to find out for his own satisfaction which machine was really the best.

He explained that at the beginning of the test it was about "nip and tuck," but when four or five boilers had been cleaned the other machine began to slow up and they were unable to get very satisfactory results. With the "Victor" Cleaner, he continued, the longer it ran the better work it accomplished.

The results of this test emphasize the claim made for the "Victor" Cleaner—that it will do as much or more work, and will last longer than any other cleaner built. These are the things that count when you have a boiler down for cleaning.

You can't afford to have a boiler idle two days for doing a cleaning job that should be done in one; neither can you afford to have the operator spend a half or more of his time making repairs to the tool.

Whether you have forty boilers with heavy scale, or only one boiler with light scale, you will find it economy in the end to use the best tool available, and for operation with air or steam that tool is the "Victor."

No scale can withstand the spurs of "Victor" Tube Cleaners.

Catalogue "H" describes the "Victor" Cleaner. Also the "Bulldog." It's the one to send for if you are interested in getting rid of scale in the easiest and fastest way.

LIBERTY MANUFACTURING CO.

6904 Susquehanna Street - - - Pittsburgh, Pa.

The "Bulldog" Cleaner—the King of all Tube Cleaners—operated by water.

If any advertisement interests you, tear it out now and place with letters to be answered.

Reversing vanes are used only between the two rows of moving buckets of the first stage wheel, being set into a bored dove tail groove in the steam end casting, and held securely in place by suitable attachments.

The bearings, which are of a suitable high speed type are fitted either with

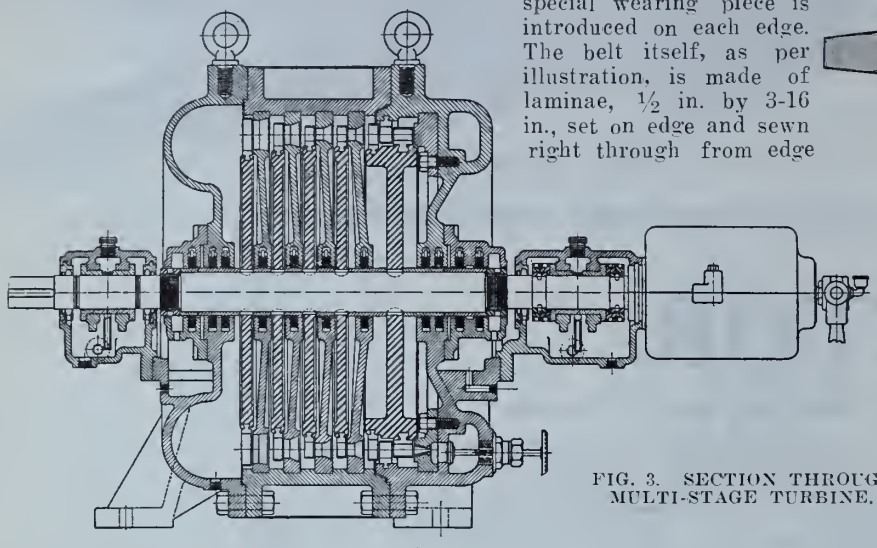


FIG. 3. SECTION THROUGH MULTI-STAGE TURBINE.

ring or forced lubrication, or both, depending on the size of turbine and operating conditions. Suitable thrust bearings are provided to maintain the rotor in its correct operating position. Where extremely close regulation is required, as in the case of generator units, an oil relay governor is fitted, a Jahns governor being used to actuate the oil relay control. For ordinary service, the governor is of the direct connected type mounted on the end of the turbine shaft and actuating a regulating valve of the double beat balanced poppet type. An overspeed governor is provided which is entirely independent of the main governor, and which, should the speed of the turbine exceed a certain predetermined amount, trips a valve in the main steam connection.

Non-condensing turbines in small sizes are usually of the single velocity stage type; and in larger sizes are of the three or five stage multi-stage type; condensing turbines up to 500 horsepower are built as five or seven stage machines. A larger number of stages is used for 500 to 1,000 horse-power machines.

PROTECTION-EDGE LAMINATED BELTING

BELTS on a planing machine are shifted from pulley to pulley every minute,

PROTECTION-EDGE LAMINATED BELTING.

sometimes every few seconds. There is therefore great wear on the edges, due to the friction of the belt forks, and the edges may be worn out while the centre of the belt is still in good condition. The result is that extensive repairs are required, involving delay and expense. To prevent this occurrence, John Tullis & Son, St. Ann's Leather Works, Glasgow, Scotland, have just introduced a protection-edge laminated belt, in which a special wearing piece is introduced on each edge. The belt itself, as per illustration, is made of laminae, ½ in. by 3-16 in., set on edge and sewn right through from edge to edge of the belt, the stitches lying on the neutral axis. The outer lamina on each side is hollowed on its outer face, as shown, and the protection strip is laid in this hollow. This strip is originally 1 in. wide by 3-16 in. thick, and it is laid against the edge of the belt like the flange against the web of an I beam. The stitches pass first through the protection strip, then through all the laminae, and finally through the second protection strip, binding them all firmly together. When the sewing is complete, the protection strip is bent into U-form, as shown, and the two limbs of the U are sewn tightly together, a layer of cement being interposed between them. The protection strip thus becomes flush with both surfaces of the belt, and its outer edge is finally rounded off.

We understand that the belt answers immediately to the touch of the belt-fork and changes pulleys instantly, effecting a marked saving of time. In a recent trial a saving of nine hours per week was registered. As there is no cross-joint, since the joints in the various laminae occur at different places, there is no jolt or jar as the belt passes over the pulley.

TO Professors Ayrton and Perry we owe not only the first ammeters and voltmeters, and the first practical clock meter —revived later as the Aron meter—but a number of improvements in moving-needle and moving-coil galvanometers, and other testing instruments.

MACHINIST'S SCREW DRIVER

A MACHINIST'S screw driver of robust construction has been put on the market by the Peck, Stow & Wilcox Co., Cleveland, O., a feature of which is a special square shank which permits the use of a wrench in turning heavy screws, enabling sufficient pressure to be

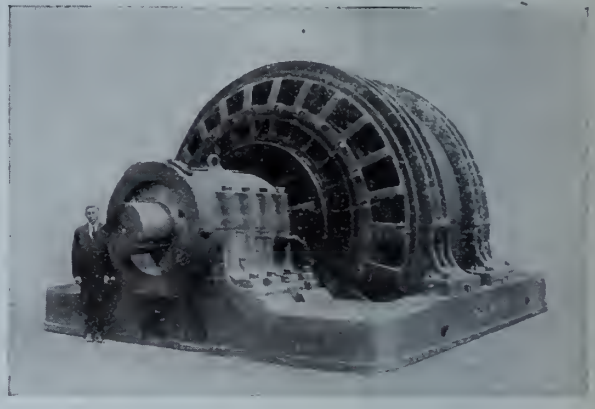
SOLID BAR MACHINISTS' SCREWDRIVER.

brought to move the most stubborn screw.

This No. 1 size screw driver, marketed under the name of Pexto, is of "Solbar" construction, a solid bar of steel forming both shank and handle, and will withstand rough usage under all conditions.

LARGE ELECTRIC MOTOR

MODERN developments in electrical power equipment are aptly illustrated by the accompanying photograph of what is said to be both the largest and most powerful electric motor ever built. The engraving shows it in the shops of the builders, the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. It is designed for driving a two-high 35 in. reversing blooming mill which reverses for every pass, i.e. every time metal goes through the rolls.

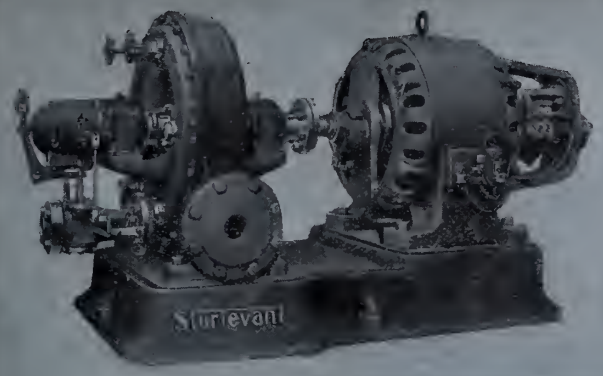


LARGE ELECTRIC MOTOR.

The horse power developed is 15,000 and reversals can be made from full speed to full speed in about 2 seconds, 19 or 20 passes being made in 2 minutes under regular working conditions. The total weight of the complete motor is over 250 tons, the rotating part alone weighing 100 tons. The overall height is 20 ft., while the shaft diameter exceeds 24 ins.

Marvels of Creation.—A Scotch preacher had been abroad and when he came back he was preaching to his congregation on the marvels he had seen.

He wound up with this: "And the same Creator who made the vast ocean, made the dewdrop. The same Creator who made the mountains made the pebble. Yes, and that same Creator who made me made a daisy!"



Sturtevant
(Trade Mark)

Generating Sets
with Turbines

Desirable power and lighting units. Perfectly balanced and free from vibration. Exhaust may be utilized for heating. Individual nozzle shut-off valves give good steam economy when operating under fractional loads.

B. F. Sturtevant Co. of Canada
Limited
GALT, ONTARIO, CANADA
MONTREAL, TORONTO, WINNIPEG, VANCOUVER
Selling Agents:
Sanford Riley Stoker Co., Ltd., "THE RILEY STOKER"

With Vertical Engines

Speed regulation is within 1½ per cent., making them particularly desirable for lighting purposes. Well adapted for isolated power plants and for auxiliaries in large plants, also for marine use.

Gasoline Engine Generating Sets also supplied. Catalogs on request.

AGENTS WANTED FOR CANADA

FOR

High Efficiency Centrifugal and Turbine Pumps

Design and Material of Highest Class

PRICES MODERATE

LARGE NUMBERS OF

Special Designs for Special Requirements

PULSOMETER ENGINEERING CO., LTD.

11 Tothill Street, LONDON

and

Nine Elms Iron Works, READING

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES.

Size	Seamless	Lap-welded
1 in.	$22 00	....
1¼ in	25 00	....
1½ in.	29 00	24 00
1¾ in.	30 00	22 50
2 in.	33 00	20 00
2½ in.	35 00	29 50
3 in.	46 00	34 50
3¼ in.	....	41 00
3½ in.	53 00	44 00
4 in.	65 00	55 00

Prices per 100 feet, Montreal and Toronto.

BOILER PLATES.

	Montreal	Toronto
Plates, ¼ to ½	$6 00	$5 75
Heads	6 35	6 00
Tank plates, 3-16 in.	6 10	5 85

WROUGHT PIPE.

Buttweld.

Prices in effect Dec. 30, 1916.

Per 100 feet—	Black	Galv.
⅛ in.	$ 4 25	$ 5 75
¼ in.	3 54	5 67
⅜ in.	3 54	5 67
½ in.	4 59	6 16
¾ in.	5 64	7 76
1 in.	8 33	11 48
1¼ in.	11 27	15 53
1½ in.	13 48	18 56
2 in.	18 13	24 98
2½ in.	28 67	39 49
3 in.	37 49	51 64
3½ in.	46 92	62 94
4 in.	55 59	75 76

Lapweld.

2 in.	21 09	27 57
2½ in.	31 59	41 83
3 in.	41 31	54 70
3½ in.	51 52	68 54
4 in.	61 04	81 21
4½ in.	71 12	94 62
5 in.	82 88	110 30
6 in.	107 50	143 00
7 in.	142 80	186 80
8 in. L.	150 00	196 30
8 in.	172 80	226 10
9 in.	207 00	270 80
10 in. L.	102 00	251 20
10 in.	247 20	323 40

Prices Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES.

4" and under, 60%.

4½" and larger, 55%.

4" and uuder, running thread, 40%.

Standard couplings, 4" and under, 50%.

4½" and larger, 30%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 10%; B and C, 10%; cast iron, 35%; standard busbings, 50%; headers, 60; flanged unions, 45; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse .....list plus 50%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL.

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 00
Steel bars, base, Toronto	4 25
Steel bars, 2 to 4 in. base	5 25
Iron bars, base, Montreal	3 95
Steel bars, base, Montreal	4 10
Reinforcing bars, base	4 05

SHEETS.

	Montreal	Toronto
Sheets, Black, No. 28	$5 50	6 15
Sheets, Black, No. 10	6 00	6 00
Canada plates, dull, 52 sheets	5 75	5 75
Canada plates, all bright	7 50	7 50
Canada plates, all bright	6 30	6 50
Apollo brand, 10¾ oz. galvanized	7 25	7 25
Queen's Head, 28 B. W. G.	8 00	6 75
Fleur-de-Lis, 28 B.W. G.	7 75	7 75
Gorbal's Best, No. 28	7 45	7 35
Colhorne Crown, No. 28	8 25	7 50
Premier, No. 28 U.S.	8 00	6 75
Premier, 10¾ oz.	7 75	7 20

PROOF COIL CHAIN.

¼ in.	$ 9 45
5-in in.	9 10
⅜ in.	8 35
7-16 in.	7 15
½ in.	6 95
9-16 in.	6 95
⅝ in.	6 80
¾ in.	6 70
⅞ in.	6 55
1 inch	6 40

Above quotations are per cwt.

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 25
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS.

	Per Cent.
Great Western, American	60
Kearney & Foot, Arcade	60
J. Barton Smith, Eagle	60
McClelland, Globe	60
Black Diamond	50
Delta Files	47½
Nicholson	50
Globe	57½
Vulcan	57½
Disston	60

OILS AND COMPOUNDS.

Castor oil, per lb.	25
Royalite, per gal., bulk	12
Machine oil, per gal.	25½
Black oil, per gal.	12½
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	0.6
Lard oil, per gal.	1.45
Union thread cutting oil antiseptic	68
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	12

BELTING—NO. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 50
Leather in sides	1 30

COAL AND COKE.

Solvay Foundry Coke	...
Connelsville Foundry Coke	...
Yough Steam Lump Coal	8 50
Pittsburgh steam lump coal	8 50
Best Slack	9 00

Net ton f.o.b. Toronto.

BOLTS, NUTS, AND SCREWS.

	Per cent.
Coach and lag screws	30
Stove bolts	55
Plate washers	10
Machine bolts, 7-16 and over	10
Machine holts, ⅜ and less.	20
Blank holts	10
Bolt ends	10
Machine screws, fl. and rd. hd. steel.	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd. brass.	add 20
Machine screws, o. and fil. hd., brass	add 25
Nuts, hex., up to 1 in., net list. Nuts square net list.	
Nuts, hex., over 1 in. $2.00 per lb. off.	
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	27½
Boiler rivets, base ¾ in. and larger	$5.25
Structural rivets, as above	5.15
Wood screws, flat, bright.	75
Wood screws, O. & R., bright	70
Wood screws, flat, brass.	42½
Wood screws, O. & R., brass.	40
Wood Screws, flat, bronze.	35
Wood screws, O. & R., bronze	32½

MISCELLANEOUS.

Solder, guaranteed	0 35
Solder, strictly	0 33
Babbitt metals	13 to 60
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	3 35
White lead, pure, cwt.	14 25
Red dry lead, 100-lb. kegs, per cwt.	13 87
Glue, French medal, lb.	0 25
Tarred slaters' paper, roll.	0 95
Gasoline, per gal., bulk	0 28½
Benzine, per gal., bulk	0 27½
Pure turpentine, single bbls., gal.	0 71
Linseed oil, raw, single, bbls.	1 12
Linseed oil, boiled, single bbls	1 15
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	8 00
Packing square braided	0 27
Packing, No. 1 Italian	0 32
Packing, No. 2 Italian	0 25
Lead wool, per lb.	0 13
Pure Manila rope	0 29½
Transmission rope, Manila	0 37½
Drilling cables, Manila	0 32½

COPPER PRODUCTS.

	Montreal	Toronto
Bars, ½ to 2 in.	$46 00	$46 00
Plain sheets, 14 oz., 14x28 in., 14x60 m	45 00	45 00
Copper sheet, tinned, 14x60, 14 oz.	54 00	54 00
Copper sheet, planished, 14x60 base.	57 00	57 00
Braziers' in sheets, 6x4 base	46 50	46 50

BRASS PRODUCTS.

Brass rods, base ½ in. to 1 in rd.	0 55
Brass sheets, 8 in. wide, 20 oz.	0 60
Brass tubing, seamles	0 55
Copper tubing, seamless	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	25%

RUBBER BELTING.

Staudard	50%
Best grades	30%

WASTE.

White	Cents per lb.
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED.

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen	10½

WOOL PACKING.

Arrow	25
Axle	20
Anvil	1
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity.

MILLED PRODUCTS.

	Per cent.
Set screws	40
Sq. & Hex. Head Cap Screws	30
Rd. & Fil. Head Cap Screws.	15
Flat & But. Hd. Cap Screws plus	15
Fin. & semi-fin, nuts up to 1 in.	30
Fin. and semi-fin. nuts, over 1 in.	25
Studs	15
Taper pins	45
Coupling bolts, plus	15
Planer head holts, without fillet	15
Planer head holts, with fillet.	net
Planer head bolt nuts, up to 1 in.	30
Planer head bolt nuts, over 1 in.	25
Planer bolt washers ...plus	10
Hollow set screws..list plus	40
Collar screws .....list plus	20
Thumb screws	20
Thumb nuts	70
Patch bolts .....add	65
Cold pressed nuts to 1½ in. .....add	3.50
Cold pressed nuts over 1½ in. .....add	2.00

METALS.

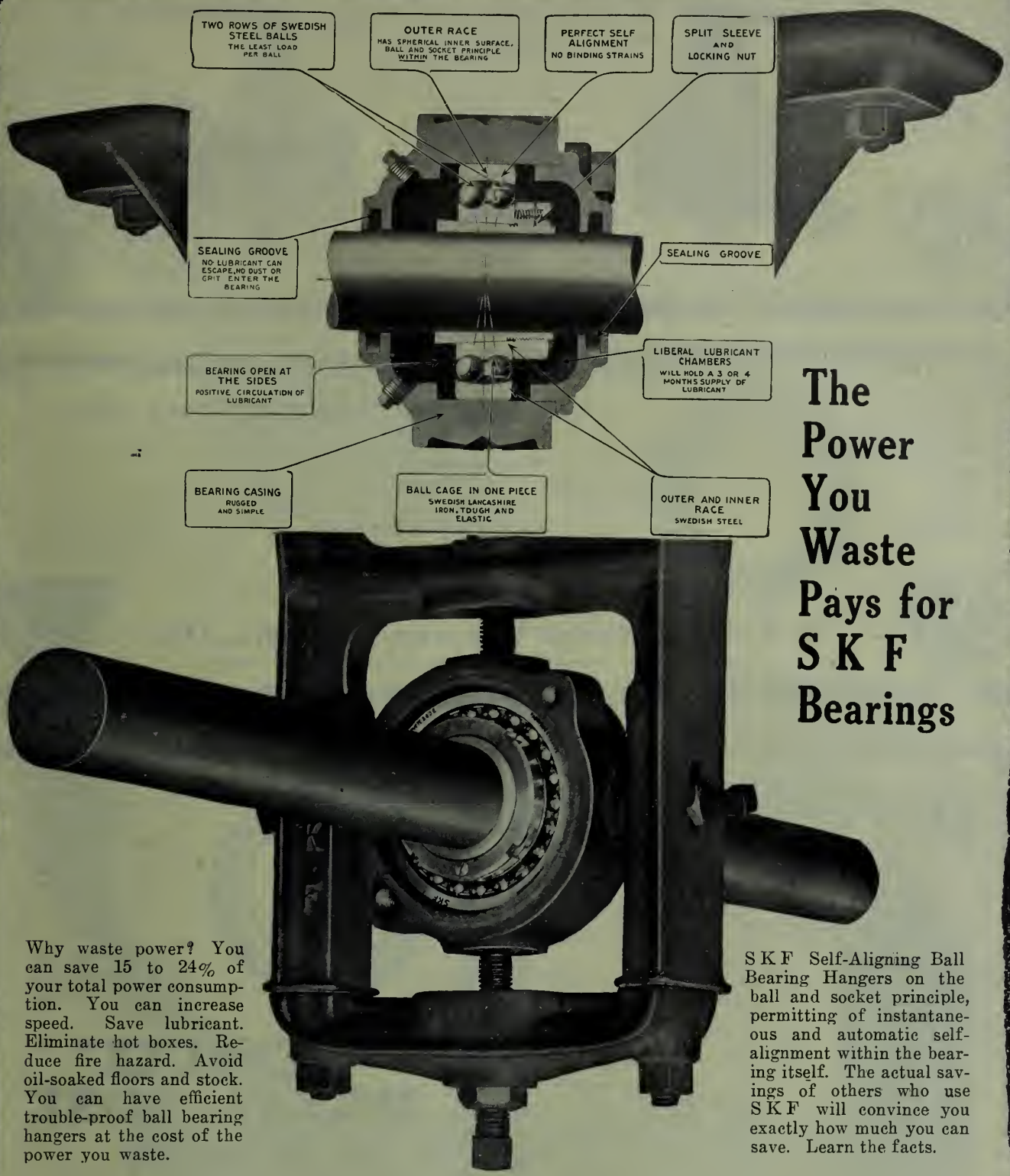
	Montreal	Toronto
Lake copper	$36 50	$38 00
Electro copper	36 50	38 00
Castings, copper.	35 50	38 00
Tin	56 00	56 00
Spelter	15 00	13 50
Lead	11 00	12 00
Antimony	37 00	35 00
Aluminum	70 00	68 00

Prices per 100 lbs.

LEAD SHEETS.

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$14.00	$14 00
Sheets, 3½ lbs. sq. ft.	14 00	14 00
Sheets, 4 to 6 lbs. sq. ft.	13 50	12 50

Cut sheets, ½c per lb. extra.
Cut sheets to size, 1c per lb. extra.


TWO ROWS OF SWEDISH STEEL BALLS
THE LEAST LOAD PER BALL
OUTER RACE
HAS SPHERICAL INNER SURFACE, BALL AND SOCKET PRINCIPLE WITHIN THE BEARING
PERFECT SELF ALIGNMENT
NO BINDING STRAINS
SPLIT SLEEVE AND LOCKING NUT
SEALING GROOVE
NO LUBRICANT CAN ESCAPE, NO DUST OR GRIT ENTER THE BEARING
SEALING GROOVE
LIBERAL LUBRICANT CHAMBERS
WILL HOLD A 3 OR 4 MONTHS SUPPLY OF LUBRICANT
BEARING OPEN AT THE SIDES
POSITIVE CIRCULATION OF LUBRICANT
BEARING CASING
RUGGED AND SIMPLE
BALL CAGE IN ONE PIECE
SWEDISH LANCASHIRE IRON, TOUGH AND ELASTIC
OUTER AND INNER RACE
SWEDISH STEEL

The Power You Waste Pays for S K F Bearings

Why waste power? You can save 15 to 24% of your total power consumption. You can increase speed. Save lubricant. Eliminate hot boxes. Reduce fire hazard. Avoid oil-soaked floors and stock. You can have efficient trouble-proof ball bearing hangers at the cost of the power you waste.

S K F Self-Aligning Ball Bearing Hangers on the ball and socket principle, permitting of instantaneous and automatic self-alignment within the bearing itself. The actual savings of others who use S K F will convince you exactly how much you can save. Learn the facts.

If you are having transmission troubles and wasting power needlessly—if you want to have a cleaner, better-looking shop—use S K F.

We will gladly send you complete literature and letters from some of the big S K F users. Ask us to send you the "EVIDENCE."

The Canadian Fairbanks-Morse Company, Limited

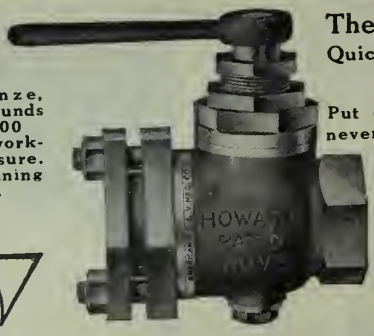
SOLE CANADIAN AGENTS FOR S K F TRANSMISSION BEARINGS

St. John Quebec Montreal Ottawa Toronto Hamilton
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

If any advertisement interests you, tear it out now and place with letters to be answered.

All Bronze, 1.000 pounds test, 300 pounds working pressure. Self-Cleaning Seat.



The Howard Improved Ball Valve

Quick, Full Opening, Absolutely Tight, and will Remain So

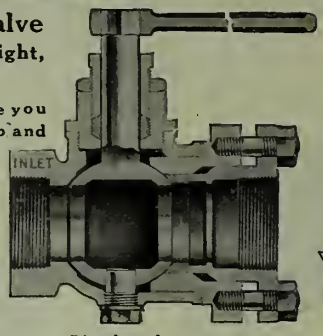
Put one of these Valves in service where you never could yet get a valve to stand up and WATCH RESULTS.

SEND FOR ILLUSTRATED DESCRIPTIVE FOLDER.

Sole Agents for Canada: CANADIAN FAIRBANKS-MORSE CO., Ltd., Montreal, Toronto, Winnipeg

American Steam Gauge & Mfg. Company

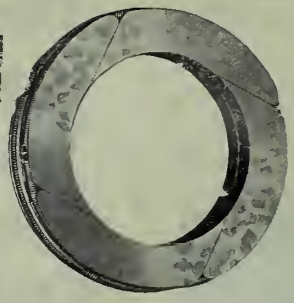
New York Chicago BOSTON Atlanta Pittsburgh



This Valve—redesigned—is offered you with the full American Guarantee.

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

MARTELL PACKINGS MEAN.. MORE POWER



USE MARTELL PACKINGS ONCE AND YOU'LL WANT THEM ALWAYS

They are up-to-the-minute packing service givers.

The secret of their superiority lies in this construction:

They are cut at a tangent to the piston rod and joints on diametrically opposed sides of the piston are parallel. This arrangement of the joints of the ring allows the parts to adjust themselves to every slight inequality of wear in the diameter of the rod as they float freely. Friction and wear upon the rod are practically negligible.

No clearance for wear adjustments need be left between the ends, and sudden failure with this type of packing is impossible. Try them now.

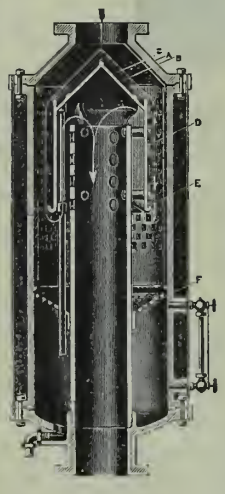
CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

The Martell Packings Company, Inc., Elyria, Ohio

Canadian Agents: THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY

820 Geddes Street - SYRACUSE, N.Y.

General Sales Agents:

Canadian Fairbanks-Morse Co., Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Vancouver, Victoria.

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

To Secure Economy from Long Service, use the Packing that has the greatest Tensile Strength in each single strand.

TEST FOR YOURSELF

a single strand of

"PALMETTO" TRADE MARK PACKING

and know why it is the packing to be relied upon for the longest service under the hard conditions of high pressure super-heated steam and compressed air.

Let us send you a free working sample.

Greene, Tweed & Co.

Sole Manufacturers

109 Duane Street, NEW YORK

Representatives in Canada

THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria

If any advertisement interests you, tear it out now and place with letters to be answered.

1851 G&K TRADE MARK REG U S PAT OFF

LEATHER PACKINGS

The value of any packing depends entirely upon its wearing qualities and power of resistance to destructive agencies.

G & K Leather Packings possess these essential qualities to the highest degree, because they are made in a correct, technical manner from leather exactly suited to the conditions under which the packings are to be used.

There are G & K Leather Packings for all ordinary requirements, there are also G & K Leather Packings which will resist to a greater degree than any other packings exposure to heat, hot or cold water, gas or acid fumes, oil, steam or other adverse conditions.

In short, for any service and every service, G & K Leather Packings mean better packing service to-day, to-morrow, and years from to-morrow.

Our Packing samples, prices and literature should interest you.

The Graton & Knight Mfg. Co.

Oak Leather Tanners and Belt Makers

WORCESTER
Mass., U. S. A.

Canadian Agents:
THE CANADIAN FAIRBANKS-MORSE CO., LIMITED
St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria

MAKERS OF 1851 G&K LEATHER BELTING

No Expansion Trouble

ALBERGER Multi-Head Heater

An apparatus that's full of superior features.

BE SURE TO READ THIS

One feature is the **Double Floating Head**—a construction that eliminates the dangers of expansion strains to which other heaters are subjected. The movable or floating heads are in sections, so as to differentiate between the expanding and contracting of the tubes of **different** temperatures.

Another is the **COPPER Corrugated** Tubes. This eliminates the segregation of materials, and splitting, so common with brass tubes. The helical spiral corrugation gives the water a whirl, which keeps the **tubes clean and free from scale.**

INCREASES HEAT UNITS BY 50% OVER THE STRAIGHT TUBES SO COMMONLY USED.

It will pay you to learn more about the "ALBERGER" Multi-Head. Send for new descriptive circular to-day.

ALBERGER HEATER COMPANY, BUFFALO, N.Y.

GENERAL SALES AGENTS:
CANADIAN FAIRBANKS-MORSE COMPANY, Limited
St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Edmonton, Vancouver, Winnipeg, Victoria

CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

A Valve is as Strong as its Weakest Link —the Disc

Make sure your discs are the kind that will give you the longest service at the least expense.

BAKELITE DISCS

have proven their ability to withstand 25,000 to 30,000 openings, under most severe conditions, without injury. Made in Fairbanks and Jenkins type.

Specify "Bakelite" Discs on your order.

PLASTICS LIMITED, Toronto

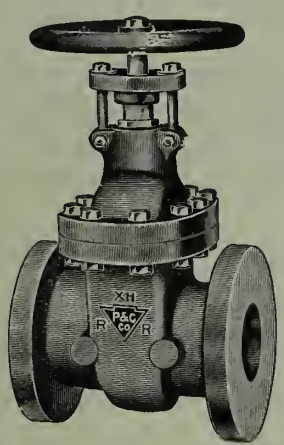
Sole Sales Agents:

The Canadian Fairbanks-Morse Company, Limited

CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

Pratt & Cady Valves



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CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

MACLEAN'S MAGAZINE *for* March

Sir Gilbert Parker
Robert W. Service
Stephen Leacock
Alan Sullivan
Agnes C. Laut
H. F. Gadsby
Erman J. Ridgeway
Madge MacBeth
L. M. Montgomery
Norman Lambert
Hopkins Moorhouse
H. M. Tandy
Robson Black
Adam Barnhart Brown
Arthur William Brown
Peter McArthur

BE thankful that Canada has a magazine of BIG calibre. A magazine fit to be placed alongside the best British and American magazines—by the test of those who contribute to it regularly and of ideals.

MACLEAN'S MAGAZINE carries world-famous names in its list of contributors—writers who have an open sesame to any magazine, yet writers that some magazines cannot get, because they fail to measure up to a standard set. Not every or any magazine can have the work of Sir Gilbert Parker, Miss Laut, Stephen Leacock, Arthur Stringer, Arthur E. McFarlane, L. M. Montgomery, Nellie McClung, Robert W. Service, Alan Sullivan, and others whose names are familiar to readers of MACLEAN'S MAGAZINE.

MACLEAN'S MAGAZINE is favored by these fine and high-priced writers because they are Canadian-born or bred and because they are genuinely interested in seeing the land of their birth or adoption have a magazine worthy of the land of their love and of their work and fame. *And they have found this magazine in MACLEAN'S.* MacLean's gives them access to the readership they desire to reach—the man and women of culture and position, of real love for Canada and in earnest to see its nationality enlarge and its destiny advanced.

And so we feel that we have a right to ask you to give MACLEAN'S MAGAZINE a first place in your favor. *It is truly Canadian,* doing a needed service for Canada, and doing this worthily. Doing all that it is doing at a heavy present cost, looking to the future for its larger reward.

You can show your appreciation of what the publishers of MACLEAN'S MAGAZINE are doing by making MACLEAN'S an elect magazine among all magazines enjoying your favor, and by making it better known to others who have your spirit—your sense of Canadian nationality, your purpose to advance Canada in all right and high ways.

At All News-Agents - Fifteen Cents -

Contents of MARCH MACLEAN'S
(CONDENSED)

Jordan is a Hard Road. Serial by Sir Gilbert Parker.

The Guile of Ulysses. By Peter McArthur.

Face Up. By Hopkins Moorhouse.

The Rabbit Revolution. By Adam Barnhart Brown, with illustrations by his brother, Arthur William Brown.

The Above are Stories

Ten Million for the Asking. By Stephen Leacock—a serious contribution on a phase of national finance.

National Policies—How they are formulated and exploited by Parties and Cabinets. By H. F. Gadsby.

Prospects for Peace and Peace's Problems. By Agnes C. Laut. A stirring and thought-provoking article by this wonderful woman writer with a statesman's mind.

The Above are Special Articles

Mrs. Hayter Reed—the woman who is responsible for the decorative schemes of the big C.P.R. hotels. By Madge MacBeth.

H. C. Brewster—Premier of British Columbia. By Norman Lambert. A timely sketch of a man of interest to all Canadians.
These are brief biographies of interesting Canadians—a feature of every issue of MACLEAN'S MAGAZINE.

The Review of Reviews Department condenses for busy readers the cream of the best things appearing in the current magazines of the world. So MACLEAN'S becomes many magazines in one.

The Business Outlook and Information for Investors are two features of MACLEAN'S greatly liked and esteemed by many of its readers.

These are Department Features found in every issue

Projects and Developments

Fergus, Ont.—Beatty Bros. are buying power house and foundry equipment.

Winnipeg, Man.—The Board of the General Hospital is considering building a power plant.

Strathroy, Ont.—The Town Council contemplate purchasing a motor driven turbine pump.

Winnipeg, Man.—The Swift Canadian Co., are considering the erection of an abattoir, to cost $3,000,000.

Cayuga, Ont.—Extensions to the waterworks system are contemplated and will include pumps, cast iron pipe, water tank, etc.

Brantford, Ont.—Fire Chief Lewis has recommended the purchase of a motor tractor for an aerial truck and a new gasoline motor pump.

Toronto, Ont.—The Deyo Macey Engine Co., Binghampton, N.Y., will establish a plant in Toronto for the manufacture of gas engines.

Tecumseh, Ont.—The Eau Claire Waterworks Co., are in the market for two centrifugal pumps and motors. R. W. Code, Windsor, Ont., is the engineer.

Chatham, Ont.—The City Council has closed a deal with the Libby packing house of Chicago to open a branch here, the city giving land for a $100,000 plant.

The Murphy Iron Works, Detroit, Mich., have been awarded a contract by the British Cordite Co. for the 400 h.p. smokeless furnace units to be installed at Nobel, Ont.

Hamilton, Ont.—The Canadian-Desmond-Stephen Mfg. Co., Urbana, Ohio, is making preparations for the erection of a plant here for the manufacture of steam ejectors, etc.

B. G. Michel, recently engineer for Carleton Place, Ont., has opened offices in the Bank of Toronto Building, Kitchener, Ont., for consulting practice in civil and sanitary engineering.

Winnipeg, Man.—The Greater Winnipeg Water District Board has authorized the commissioners to call tenders for cast iron pipes, valves and specials for the pipe line between the Red River and McPhillipps Street reservoir. The estimated cost is about $250,000.

Niagara Falls, Ont.—The Hydro-Electric Power Commission are buying a large quantity of contractors' plant in connection with their Chippewa Creek development here, including rubber belting, motors, cement, conveyors, electric hoists, derricks, locomotive cranes, small jaw crushers, concrete mixers and machinery, etc.

Toronto, Ont.—Tenders addressed to the chairman of the Toronto Electric Commissioners will be received until March 28, for synchronous condensers. Specifications may be obtained at the office of the Purchasing Agent, 15 Wilton Ave., Toronto.

The Canadian SKF Co. has opened an office at 47 King Street West, Toronto, where a complete stock of ball bearings will be carried. The Canadian Fairbanks Morse Co., will continue as sales agents for transmission equipment made by the parent concern at Hartford, Conn.

Water Purification Ltd., has been incorporated at Ottawa with a capital of $40,000 to manufacture and deal in water purification and filtration plants at Ottawa, Ont. The incorporators are E. M. Knight, J. T. Mitchell and W. A. Wyman all of Ottawa.

The Albany Pump Co. has equipped a plant at 16 Pearl street, Toronto, for making the "Albany" rotary pump and munitions gauges. A. W. Bennet, who is proprietor and manager of the concern, formerly carried on business at 206 King street west, Toronto, as Canadian agent for the "Albany" pump.

Kerry & Chace, Ltd., engineers confederation Life Building, Toronto, are interested in liquid chlorine apparatus and will be glad to receive literature on any plants of proved merit. This firm will be in the market at a later date for plants of this type.

The Canadian S K F Co., has now been incorporated at Ottawa with a capital of $50,000 to manufacture and sell ball bearings and machinery at Toronto. The incorporators are Allan H. MacCaffray of Hartford Conn., also Percy O. G. Jones and James D. Becking of Toronto.

Winnipeg, Man.—The Greater Winnipeg District Board has decided to award the contract for the construction of ten miles of pipe line, at a cost of $1,300,000, to the Winnipeg Aqueduct Construction Co. The matter, however, has not been finally settled, as other contractors have raised objections over the award.

Frank Gilbert a well known engineer died at his home in Montreal on Jan. 23, after a long illness. Mr. Gilbert was born in Montreal in 1847. After graduating at McGill University, he started in 1870 in the foundry business, later joining the firm of E. E. Gilbert & Sons, engineers and contractors. The deceased took an active part in the construction of the Lachine Canal and also of the Galops Canal. Mr. Gilbert founded the old Canadian Engine Works.

The George T. Ladd Co., Pittsburgh, Pa., announce that the name of what was originally the "Milne" boiler has been changed to the "Ladd" water tube boiler. The change has been made on account of improvement in design affecting the settings, feed boxes and other details to the extent that the majority of the patents which the company are utilizing have been taken out by George T. Ladd, president of the company.

Paul J. Myler has been appointed president of the Canadian Westinghouse Co., Hamilton, Ont. For a long time Mr. Myler was vice-president and general manager, but relinquished the duties of general manager some time ago. **F. A. Merrick** has been appointed vice-president and general manager. **H. H. Westinghouse,** the former president of the company, has been appointed to the position of chairman of the board, a new position which has been created.

C. S. C. E. Elect Officers.—The newly elected members of Council are J. S. Dennis, Montreal, president; J. M. R. Fairburn, Montreal and C. N. Montserrat, Montreal, vice-presidents; and A. R. Decary, of Quebec, J. H. Kennedy, of Vancouver, H. Longley, of St. John, N.B., G. A. McCarthy, of Toronto, W. Pearce, of Calgary, R. A. Ross, of Montreal, J. C. Smith, of Montreal and James White, of Ottawa, Councillors

The Sterling Engine Works have taken over the plant and business of the Doty Engine Works, Winnipeg, with works and office at the foot of Water Street. While it is their intention to manufacture farm tractors as a specialty, they will also make boilers, steam and gasoline engines, iron and brass castings, cut gears, for which their plant is specially equipped, as well as general repair work. The president of the new company is V. C. Maddock, the secretary-treasurer F. Nilan, and W. J. Leaney is manager.

Hamilton, Ont—Tenders will be received by the Board of Control up to March 5, for the supply of ordinary asd special castings, iron pipe, hydrants, valves, extension boxes. Lead pipe—Pig lead, rubber hose, rubber boots, road oil, lubricating oil, flux, fuel oil, coal oil, gasoline, brass work, including ordinary and special brass castings for water department, hardware, etc. Specifications may be obtained at the office of E. R. Gray, City Engineer.

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Booklet 222T. tells all about it.

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Joseph Dixon Crucible Company
Established 1827

Canadian Representative:
Canadian Asbestos Co.,
Montreal, Que.

Toronto, Ont.—Tenders will be received, addressed to the Chairman, Board of Control, City Hall, up to Feb. 27,, for the construction of a drainage system (wrought iron pipe), for the Rosedale bridge, Bloor Street Viaduct. Specifications and forms of tender may be obtained upon application at the Bloor Street Viaduct field office, 89 Castle Frank Road, Toronto.

Winnipeg, Man.—Tenders will be received up to March 15, by R. D. Waugh, Chairman of Commissioners, Greater Winnipeg Water District, for the supply of approximately 12,500 feet of 48-in. and 1,300 feet of 60-in. cast iron pipes, together with specials and gate valves. Specifications on application to the offices of the District, 501 Tribune Building, Winnipeg.

CATALOGUES

The Valve Twins is the title of a bulletin being distributed by the Homestead Valve Mfg. Co., Homestead, Pa., illustrating the "Hovalco-Homestead" blow-off combination valve.

Boiler Feed Pumps.—The G. H. Tod Co., Ltd., have issued a bulletin illustrating and describing the Tod-Attwood patent vertical ram boiler feed pumps, The principal features of this pump are dealt with in detail, while a table is included giving the principal dimensions and other particulars for each size.

Firebrick Blocks.—A new bulletin dealing with the "Gates" firebrick blocks has been issued by John W. Gates, Montreal. The application of these firebrick blocks is shown by means of a number of illustrations accompanied by descriptive matter. The bulletin describes all types of blocks now being used largely in place of ordinary firebrick.

Steam Traps.—Bulletin No. 5 describes an interesting line of steam traps, made by the Geo. W. Cole Co., Toronto. The principal features of the "Cole" direct return trap are dealt with while the essential particulars and prices are given covering the various sizes. The bulletin is illustrated and includes a diagram showing a double trap installation with a table of fuel losses.

Sub-Aqueous Lubrication, Bulletin issued by the Crew Levick Co., Philadelphia, Pa., dealing with sub-aqueous or under-water lubrication in hydro-electric stations with special reference to hydro-turbine lubrication at McCall's Ferry, Pa. The preparations described are "Turboglio" for under-water lubrication and "hydroglio" for governor lubrication.

Belt Sewing Machine—Bulletin illustrating and describing a wire belt sewing machine made by Joseph Appleyard, Bradford, Yorks, England. Each type of machine for sewing various sizes of belts is illustrated and described, the principal dimensions and shipping weight being given for each size. One page contains a number of illustrations showing the different classes and thicknesses of machine belting which these machines will sew. A large number of testimonials are included from users in various parts of the world.

Nonpareil High Pressure covering for heated surfaces is the title of an interesting and attractive publication recently issued by the Armstrong Cork Co., Pittsburgh, Pa. The booklet contains 84 pages and deals fully with the subject of insulation for high pressure and superheated steam lines, boilers, breechings, feed water heaters, etc. An interesting feature is a list of comparative tests made at the company's Beaver Falls factory, as a result of which they have been able to fix definitely the heat losses from various sizes of pipe both covered and uncovered. These losses are given in B.T.U. per lineal foot, per degree difference in temperature for twenty-four hours and are tabulated. In the following pages are tables which show in a general way, the most economical thickness of "Nonpareil" high pressure covering to use, based on different steam costs. A complete set of specifications is also included dealing with the correct installation of these various thicknesses of covering. The booklet is fully illustrated and is exceptionally well gotten up. It contains a great deal of interesting and useful information. Copies may be had on request by interested readers.

BOOK REVIEW

Steam Boilers and Combustion, by John Batey. 220 pages, 4⅜ in. x 7¼ in., with 18 diagrams. Published by Scott, Greenwood & Son, London, England. Price $1.25, post free. This volume is the fifteenth of the Broadway Series of Engineering Handbooks. In this book the author has striven to deal with the subject in a somewhat different manner than that usually found in works on this subject. Problems of combustion are examined and as far as possible cause is traced back from effect, the causes being referred to well known facts as a comparison. Although the application of certain principles is sometimes questioned, they are accepted as a whole. All analysis is based on recognized science and results compared with authorized deductions. The book contains an introduction and seventeen chapters, dealing successively with various subjects, such as combustion and steam production, principal constructional features of various types of steam boiler, steam boiler practice, temperature, etc. This briefly covers chapters one to twelve, inclusive. The principal subjects dealt with in the concluding chapters include lessons taught by experiment, Philadelphian exhibition lists, normal results obtained by abnormal methods, analysis of actual performance of a locomotive boiler and lastly, movement of gases through tubes. The book, while being in a measure technical, is clear and concise, and contains much valuable information on

NON-FLUID OIL

Not affected by heat or cold. Temperature Proof

Among other sterling qualities and advantages of NON-FLUID OIL, the quality of being **temperature proof** is a great convenience and makes a big saving in time and in the cost of running operations.

Where extremes of temperature are experienced NON-FLUID OIL may be used to great advantage.

NON-FLUID OIL operates with equal readiness summer or winter, outdoors or near the boilers.

Applied in every bearing from the engine to the hauling up and cantering machinery, Non-Fluid Oil will save enough fuel and repairs in a year to buy lubricants for ten years. There is no loss from dripping and fire risk is minimized. High speed bearings run perceptibly cooler and are longer lived.

We strongly advise a long, accurate test of the claims we have made for these lubricants. Samples for the purpose will be gladly furnished free on request. Ask for literature giving full particulars.

Fred Smith

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U.S. METAL POLISH

Works Equally Well on Hot and Cold Surfaces. It Cannot Blow Up. Cleans, Polishes and Preserves all kinds of metals.

Tear this off as a reminder

Geo. Wm. Hoffman Co., 557 E. Wash. St. Indianapolis, Ind.

Enclosed find 10c in stamps, for which send me one large 50c can of U. S. Metal Polish Paste.

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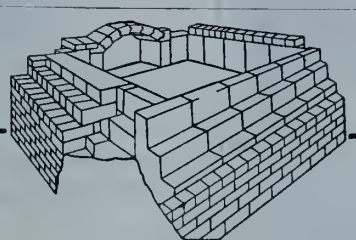
WANTED — EXPERIENCED GAS ENGINeer; some knowledge of electrical work; must be first-class engineer. Reply, stating experience and wages. Box 273, The Power Power House. (3)

a phase of boiler operation which is frequently not given the attention that its importance merits. In addition to the diagrams, the book contains a number of tables and some useful rules and examples.

Heaton's Annual, Heaton's Agency, Toronto, price $1 net. The thirteenth edition of Heaton's Annual has just come from the press, and again we have to note improvements and refinements which have marked its progress from year to year. Heaton's Annual endures because recognized as a necessity both in the office and the home. Indeed, to financial or commercial houses in Canada or abroad and who do business with Canada, the book is indispensable, the expression, "Look it up in Heaton's," having become a habit in many households. The first part of the book contains complete official directories of the Dominion and Provincial Governments, to which is added this year a long list of titled and decorated Canadians that will be of interest to many families who have boys at the front; also postal information; a shipper's guide, giving every banking town, with banks and railway connections, population, etc.; commercial regulations and complete customs tariff revised to date. In the last half of the book we find up-to-date complete descriptions of every commercial town in Canada with hotels, industries, population and industrial opportunities, and an invaluable and complete summary of the resources of the Dominion, covering agriculture, agricultural districts, finance, fisheries, forests, fur farming, mining, sport, water powers, etc. The information is full, live, clearly arranged and concisely stated. Cross references are given throughout the text to a most valuable bibliography of Government and standard publications under the heading, "Where to Find It," so that the reader has access to complete information upon any subject in which he is interested.



Gates Boiler Furnace

Patent Applied For

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any bandy man or fireman can renew them without disturbing any of the other brick work.

—WRITE FOR PARTICULARS—

John W. Gates, 382 St. James St., Montreal, Que.

Do You Know Why The Steam Trap SARCO

Is used by nearly all the big industrial concerns?

THIS IS WHY

The Steam Trap SARCO is operated by the expansion of a liquid operating a spirally corrugated tube. There is no other steam trap made which uses liquid expansion and none can use this enormously powerful and reliable operating medium without using also the Sarco tube. Therefore of all thermostatic traps the SARCO claims to be the most positive—and it can be supplied not only for vacuum heating systems but for low pressure and high pressure steam up to 200 lbs. Do you know any other thermostatic trap used successfully for pressures above 50 lbs. or even as high.

Then as to installation. The SARCO fits in anywhere. (1" size measures only 7½"); it needs no floor space or building up, but can be used as an elbow or bend, in the discharge. Although it does just the same work, it is not a heavy, cumbersome affair like a float or bucket trap. It is not a tank, but a piece of live pipe. It cannot freeze and will not permit freezing of the pipe line. Unless steam is in the line the trap is wide open to discharge.

Price—it is the cheapest trap on the market in first cost—cost of installation and cost of upkeep.

Take a trap on thirty days' trial and prove this for yourself.

Write for Bulletin 11.

SARCO COMPANY INC.

Woolworth Building New York,
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A trial will convince you. Write for Catalog

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NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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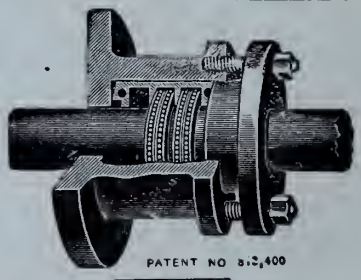
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



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HOLMES' Metallic Packing

is Guaranteed 3 years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

Holmes Metallic Packing Co., Wilkes-Barre, Pa.

Reilly Multicoil Feed Water Heater

Has greater capacity per square foot of heating surface than any other type of closed heater. It is simple in construction, light in weight and small in size.

Write for Bulletin No. 210.

Canadian Griscom-Russell Co., Ltd
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Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

Boving Hydraulic & Engineering Co., Limited
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THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
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Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

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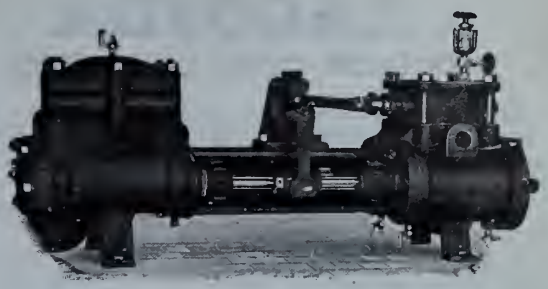

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OSTER
Bulldog Die-Stocks

make pipe-threading easy—they cut useful threads on the job and cut out useless moves between jobs. 11 sizes. Write for "The Bulldog Tale."

THE OSTER MFG. CO.
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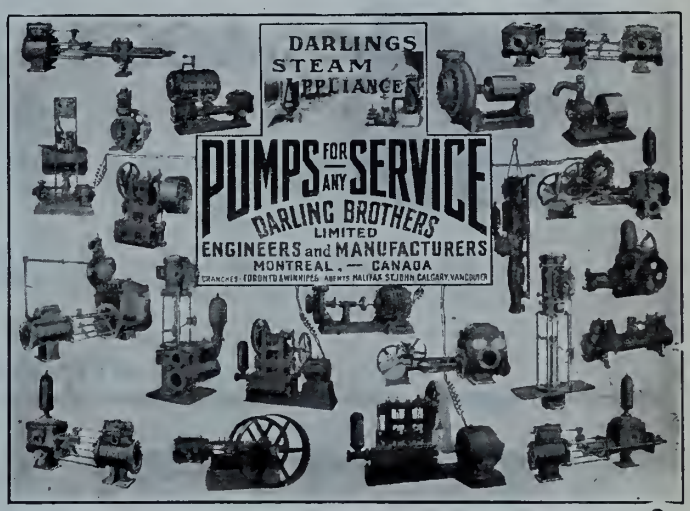

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Free to Engineers

This work is an important aid to engineers of all grades, and is undoubtedly the most helpful ever issued relating to a safe and sure preparation for examination. It presents in a condensed form the most approved practice in the care and management of Steam Boilers, Engines, Pumps, Electrical and Refrigerating Machines, also a few plain rules of arithmetic with examples of how to work the problems relating to the safety valve, strength of boilers and horse power of the Steam Engine and Steam Boiler.

It contains various rules, regulation and laws of large cities for the examination of boilers and the licensing of engineers.

The book gives the underlying principles of steam engineering in plain language, with very many sample questions and answers likely to be asked by the examiner.

It also gives a short chapter on the "Key to Success" in obtaining knowledge necessary for advancement in engineering.

This helpful volume contains 200 pages of valuable information not elsewhere obtainable; it is bound in rich red leather with full gold edges and titles; it measures 5x7½ inches, and weighs twenty-two ounces.

Price, $2. Free for 3 NEW prepaid subscriptions to The Power House.

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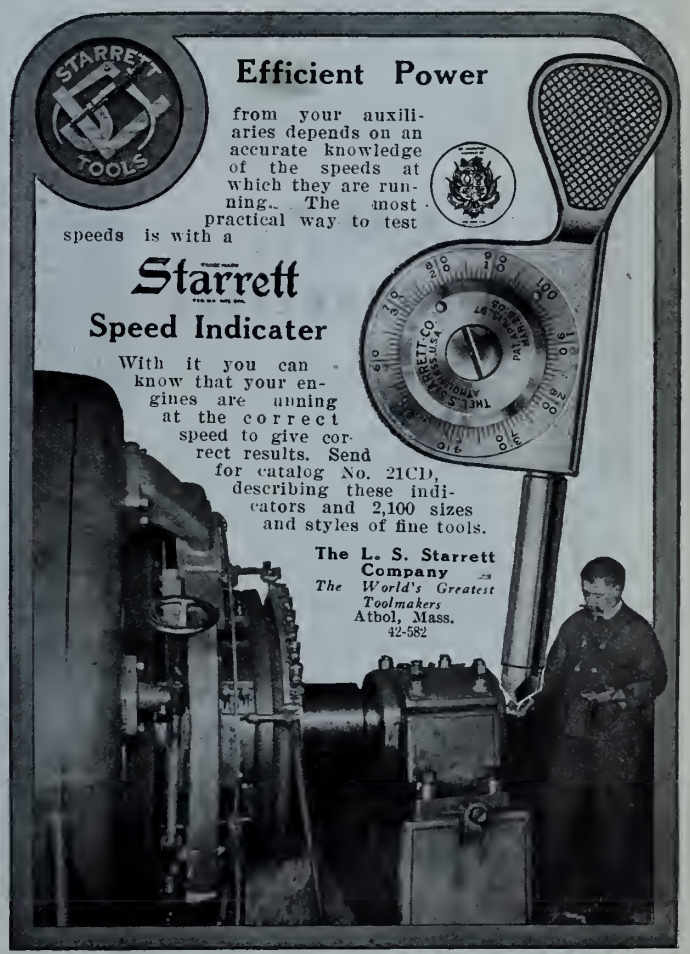
143-153 University Avenue, TORONTO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Efficient Power
from your auxiliaries depends on an accurate knowledge of the speeds at which they are running. The most practical way to test speeds is with a
Starrett
Speed Indicater
With it you can know that your engines are running at the correct speed to give correct results. Send for catalog No. 21CD, describing these indicators and 2,100 sizes and styles of fine tools.
The L. S. Starrett Company
The World's Greatest Toolmakers
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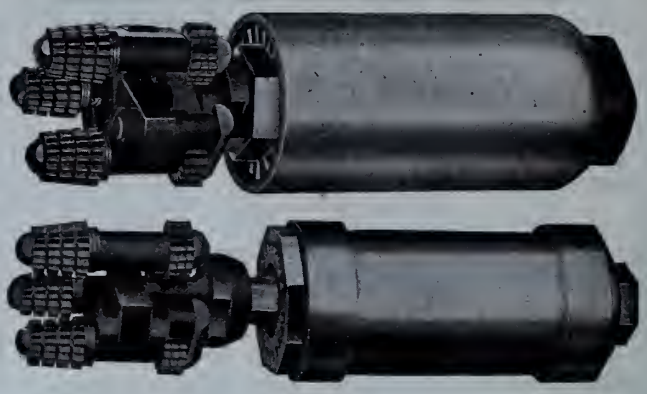
LAGONDA
BOILER TUBE CLEANERS

The latest Lagonda Water and Air-Driven Boiler Tube Cleaners are the most powerful and efficient tube cleaners made. They develop higher speed and greater power than has heretofore been secured with any Turbine Cleaner, and their use will materially shorten the time required in cleaning boilers.

These new Lagonda Cleaners are built for all sizes of tubes, either straight or curved, and they can be driven by water, air or steam.

Ask for Catalog L.



LAGONDA Multiple Water Strainers

The Lagonda Multiple Water Strainer in your water supply main will remove all objectionable solid matter and insure constant and economic conditions of pump and condenser operation. They are easily and quickly cleaned, without interruption of water supply, and take up small floor space. **Ask for Catalog R-2.**

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Guides to Efficiency

The high efficiency of your Plant cannot be maintained without an accurate knowledge of the steam and water temperatures and pressures.

H&M *Tycos* THERMOMETERS

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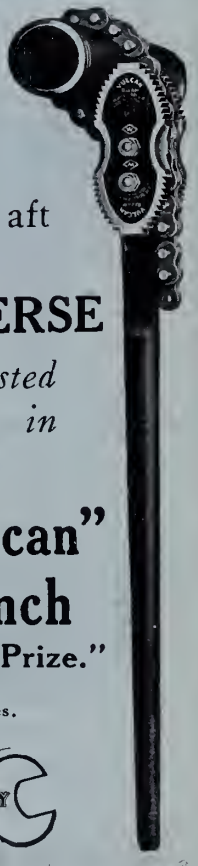

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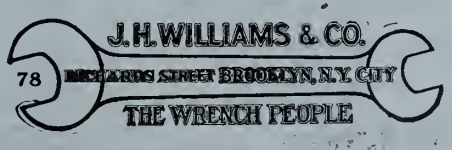

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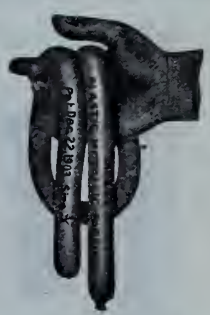

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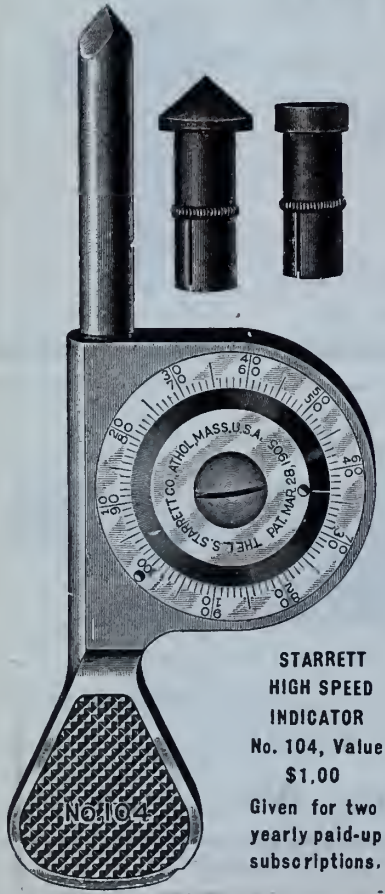

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is the power plant of the Ft. Worth Light, Heat and Power Co., Texas. On the inside the coal is stored above the boilers in a Brownhoist Concrete Bin, which time has proved will last as long as the plant and require no repairs. The coal is unloaded on the outside by a Brownhoist Locomotive Crane, which takes it from the cars and places it in storage or puts it through the roof into the Brownhoist Bin. It is safe to say that this plant will have very little trouble, if any, with its coal handling apparatus.

BROWNHOIST

Concrete Coal Bin and Coal Handling Machinery

Write for Catalog S

The Brownhoist Concrete Bin is a steel bin, lined inside and out with concrete. This protects all steel from the corrosive action of the coal or ashes. The oldest one of these bins has been in continuous service for 14 years and has required no repairs. Brownhoist Coal Handling Machines are of various types and sizes for safe, rapid and economical handling of coal. These machines and the bin are described and shown in Catalog S.

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Branch Offices in New York, Pittsburgh, Chicago, San Francisco, Montreal and (Portland, Ore., Colby, Eng. Co.)

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CURTIS Water Pressure Regulator

The Economy of this Curtis Water Pressure Regulator (See Illustration) lies in the fact that it greatly reduces the cost of keeping plumbing in order—This by obviating the wear and tear of water hammer or concussion in pipes.

This regulator is warranted to maintain the pressure desired, **with perfect uniformity, regardless of any fluctuations of outside pressure.** The workmanship and material of the Regulator **cannot be excelled.** Trouble from rust or clogging is **entirely avoided.** Delivery of water into service pipes at any desired pressure **is guaranteed.**

Send for special leaflet and price list to the manufacturers.

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Engineers with long experience will tell you that

Homestead Guaranteed Valves

are the best for all Water, Air or Steam Lines

Simple in construction, easy to operate, and the only valve which will successfully stand up under the heaviest duty service. Made in Straightway, Threeway and Fourway patterns. Special valves for special purposes.

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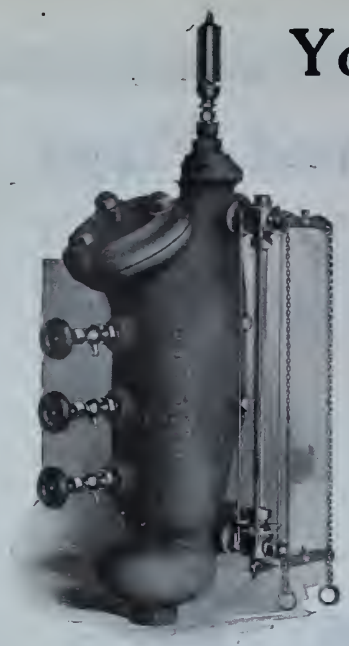

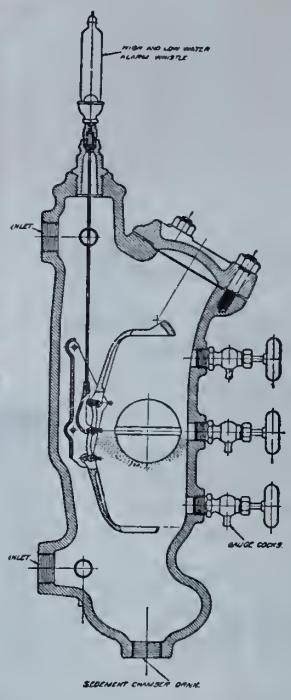

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the instant the water in your boilers falls below or rises above the danger point if you equip your boilers with the

Anderson Safety Water Column

It never fails. Always ready for action when the need calls.

The entire mechanism is assembled as a single unit, a removable hanger frame, and hung on accurately machined bronze pivots. The working parts cannot rust or stick.

Write for catalog and full details.

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INDEX TO ADVERTISERS

	PAGE
A	
Albany Lubricating Co.	23
Alberger Heater Co.	69
American Pulley Co.	15
American Steam Gauge & Valve Mfg. Co.	66
American Steam Pump Co.	29
Anderson Co., V. D.	86
Armstrong Cork Insulation Co.	25
B	
Babbitt Steam Specialty Co.	20
Babcock & Wilcox	76
Bawden Machine Co., Ltd.	7
Boiler Inspection Dept.	14
Boving Hydraulic & Eng. Co.	74
Bowser, S. F., & Co., Inc.	83
Brown Hoisting Machy. Co.	85
C	
Can. B. K. Morton Co.	17
Can. Detroit Lub. Co.	23
Can. Fairbanks-Morse Co.	65
Can. Griscom-Russell Co., Ltd.	74
Can. Laco-Philips Co., Ltd.	11
Can. Morehead Mfg. Co.	14
Can. Sirocco Co.	28
Chaplin-Fulton Co.	8
Cling-Surface Co.	23
Coppus Eng. & Equip. Co.	7
Crown Mfg. Co.	10
D	
Darling Bros.	75
Dart Union Co.	13
Davis Regulator Co.	29
D'Este Co., Julian	85
De Laval Steam Turbine Co.	28
Direct Separator Co.	66
Dixon Crucible Co., Jos.	72
Dominion Belting Co.	20
Dominion Coal Co.	74
E	
Economy Fuse & Mfg. Co. of Canada	4
Escher Wyss & Co.	18
F	
Foxboro Co.	76
Francis, Walter J., & Co.	72
Frick Co.	26
G	
Galt Foundry Co.	9
Garlock Packing Co.	16
Garth Co.	74
Gates, John W.	73
Goldie & McCulloch Co.	32
Graton & Knight Mfg. Co.	68
Greene, Tweed & Co.	67
H	
Hoffman, G. W.	73
Holmes Metallic Packing Co.	74
Homestead Valve Mfg. Co.	85
Hoyt Metal Co.	2
I	
Inglis Co., John.	Inside back cover
J	
Jamison Cold Storage Door Co.	26
Jenckes Machine Co.	2
Jenkins Bros.	5
Jones Underfeed Stoker Co., Ltd.	13
Jordan Bros., Inc.	4
K	
Kerr Engine Co.	9
L	
Ladd, The Geo., Co.	75
Laurie & Lamb	27
Liberty Mfg. Co.	61
Linde Canadian Refrigeration Works Co.	24
Lunkenheimer	12
M	
MacGovern & Co.	81
MacKinnon, Holmes & Co.	72
Magnolia Metal Co.	18
Martel Packings Co.	66
Mason Regulator Co.	6
McAvity & Sons, T.	8
McDougall Caledonian Iron Works Co.	30
McGhie, W. C.	74
McLaren, D. K., Ltd.	19
Morris Machine Works	28
Morrison Brass Mfg. Co., Jas.	Outside back cover
Morse Chain Co.	21
Murphy Iron Works	4
N	
Nashua Mach. Works	6
National Steam Pump Co.	29
O	
Oster Mfg. Co.	75
P	
Peerless Rubber Co.	Inside front cover
Peiler & Co., H. L.	6
Penberthy Injector Co., Ltd.,	Outside front cover
Pennsylvania Flexible Metallic Tubing Co.	66
Pierce Co., Wm. B.	14
Plastics, Ltd.	69
Polson Iron Works	8
Pratt & Cady Co.	69
Pulsometer Engineering Co.	63
R	
Roto Company, The	20
S	
Sarco Co., Inc.	73
"S-C" Regulator Co., The	8
Scaife, Wm. B., & Sons Co.	84
Schaeffer & Budenberg Mfg. Co.	7
Smart-Turner Mach. Co.	75
Smith, Fred	73
Snowdon, C. C.	22
Spray Engineering Co.	79
Starrett, L. S., Co.	75
Steel Mill Packing Co.	83
Storey Pump & Equipment Co.	28
Sturtevant, B. F., Co., of Canada	63
T	
Taylor Instrument Co.	76
Thomas Grate Bar Co.	83
Trimont Manufacturing Co.	81
Turbine Equipment Co., Toronto	28
U	
Uehling Instrument Co.	79
V	
Vilter Mfg. Co.	24
W	
Wall, W. J.	73
Waterous Engine Works Co.	1
Watson & McDaniel Co.	74
Williams & Co., J. H.	81
Y	
York Mfg. Co.	25

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Boilers

Inglis Boilers are Canadian Standard in materials, workmanship, value and service.

They are constructed for a life-time service with a minimum of repairs. Satisfaction is double-sure.

We make boilers for all kinds of service, and are also sole Canadian Manufacturers of the *Erie City Water Tube Boilers.*

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Reducing Valves

NON-EQUALIZING
EXTREMELY SENSITIVE
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The Non-Equalizing feature of the J.M.T. Standard Reducing Valves will surely commend itself to you. A guarantee of a perfectly uniform and dependable service, is remarkably sensitive for control, and is really a long step in advance of Reducing Valve construction.

Made in bronze, ½ in. to 2 in., and iron body, bronze mounted, 2½ in. to 6 in., for various steam ranges between ½ lb. and 300 lbs.

The J.M.T. Improved Automatic Injector

An Injector having a full forty pounds more field than anything heretofore produced and giving absolute service under varying conditions.

A culmination of valuable experience in design and the making of Injectors, likewise increasing the use for Injectors. Will operate successfully on 20 lbs. low to 220 lbs. high steam pressure, from 4 to 400 horse-power, and made in sizes from ⅜-in. to 2-in.

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A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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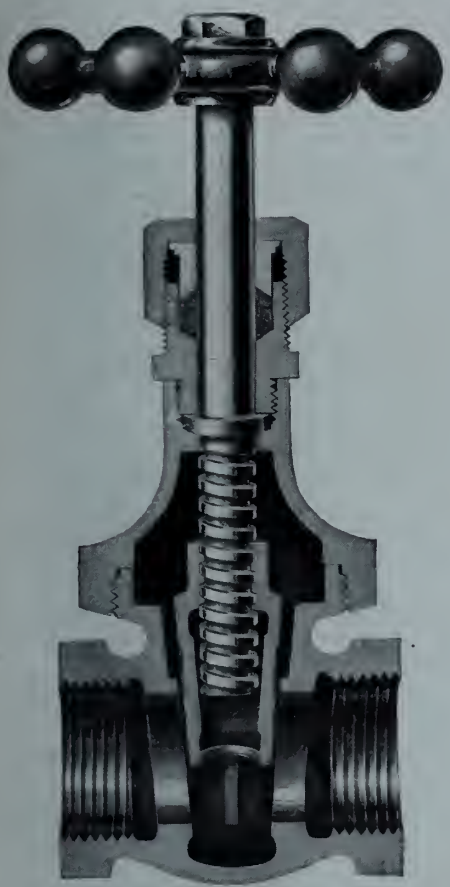

"The gate that's up-to-date"

TRADE PENBERTHY MARK

Brass Gate Valves

APPROVED AND REGISTERED

Some Excellent Features:

Outside Bonnet Construction (*Strong where others are weak.*)

Solid Wedge Disc

Non-Rising Spindle

Packing Gland with Follower

Best Quality Steam Metal

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No Other Gate Valve

on the market is as pleasing in design, perfect in workmanship, or as satisfactory in service, and the ripe experience of over a quarter of a century in the manufacture of high grade brass goods is a guarantee that Penberthy Gate Valves will give you real lasting service. Get the genuine and look for our trade mark when you buy Valves. **Stocked by Leading Jobbers.**

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THERE ARE NO "BLOW-OUTS"

IN THE PLANT WHEN

RAINBOW RED SHEET

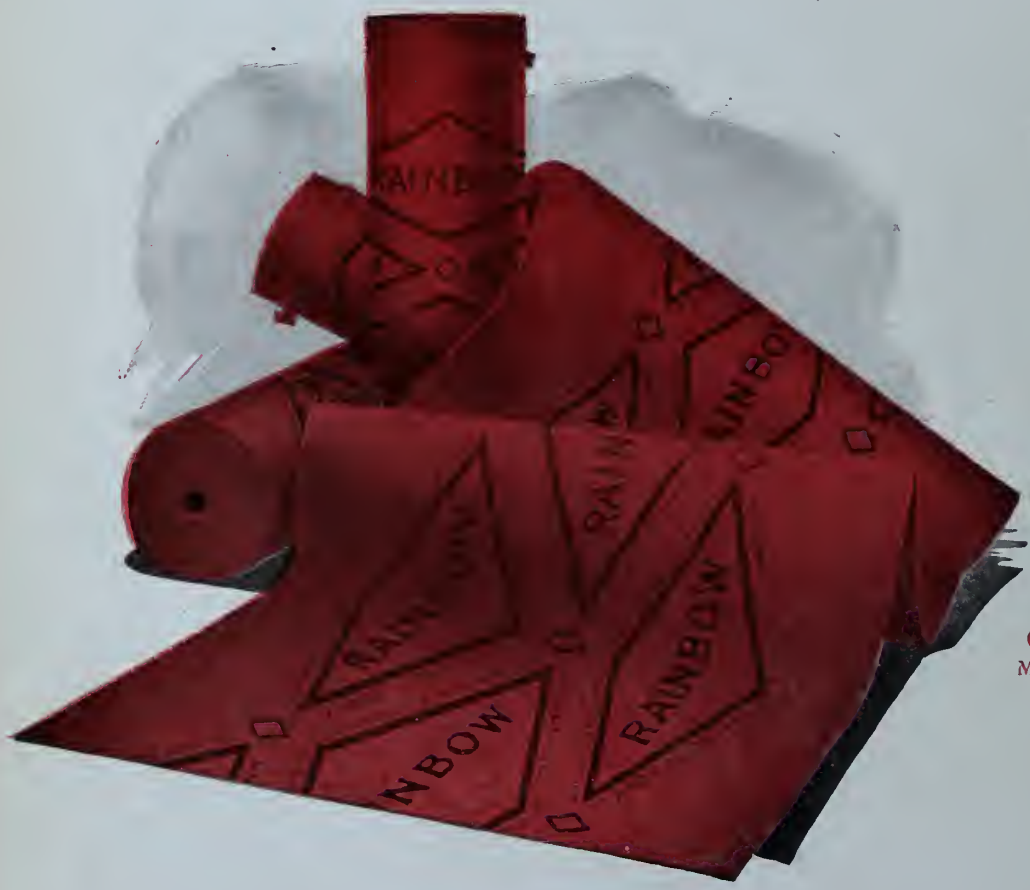
IS IN THE FLANGES.

IT IS YOUR INSURANCE AGAINST

"SHUT-DOWNS" THAT ARE SO COSTLY

TO THE BUSY MANUFACTURER.

USE IT ON THE NEXT JOINT YOU PACK



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Canadian Representatives:

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Carry a large stock
of all sizes
for your convenience

Central Station Economy In Your Own Power Plant

WATEROUS HIGH SPEED McEWEN ENGINES

These engines are built specially for use in the isolated plant. High speed and close regulation recommend them for electric light and power production, mill work and general industrial purposes.

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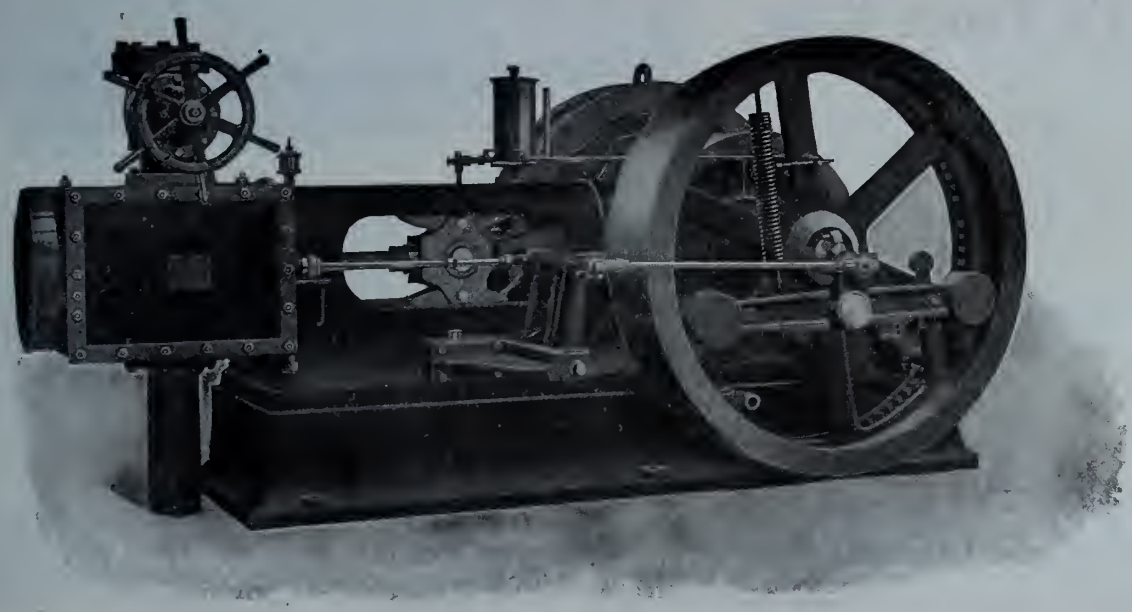
In hundreds of Canadian power plants producing their own power you will find McEwen Engines in use. They are in operation because they are developing power that is not only cheap but absolutely reliable as well.

McEwen Engines are built for continuous duty — there are no shut downs because something has gone wrong on the transmission line.

Built in simple and compound units up to 700 H.P. capacity.
May we send bulletin and list of Canadian users?

The Waterous Engine Works Co.. Ltd. BRANTFORD CANADA



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VERTICAL TUBULAR

LOCOMOTIVE TYPES
HEATING BOILERS

JENCKES BOILERS

Are quality constructed from start to finish. Extra service is built into them, and they're constructed in accordance with any Provincial Boiler Code.
Prompt shipment of Standard Boilers, subject to prior sale.
We have on hand a large assortment of plates and tubes.
Enquiries invited.
Quick action may avert disappointment.

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Sherbrooke Montreal St. Catharines Toronto Cobalt South Porcupine Nelson Vancouver
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Cut down the babbitt expense of your plant

by using

Hoyt's Frost King

It sets a pace in service that puts it in a class by itself. Not only takes care of high speed, but has wonderful ability to withstand heavy duty.

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For dynamo and motor work use

Hoyt's Dynamo Genuine

Gives the best service under severe duty.

Order from your dealer; if he cannot supply you we will be pleased to make you a shipment of a twenty-five pound box.

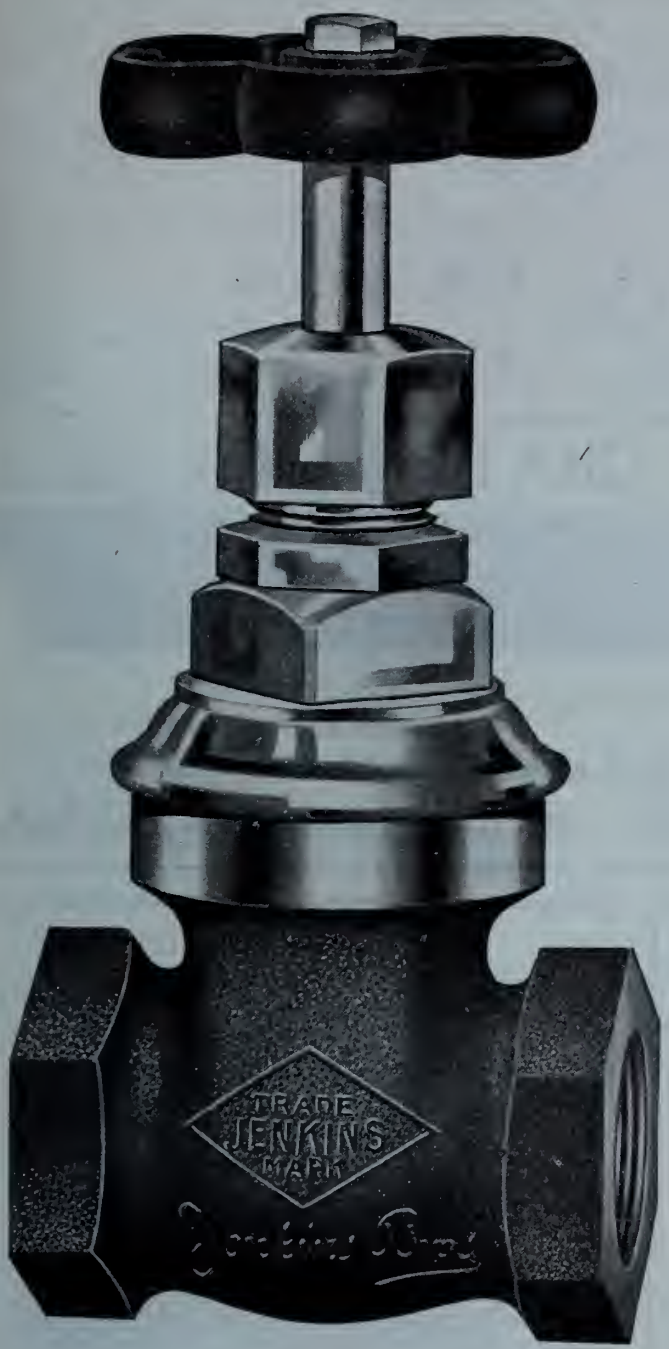

FIG. 300

What will serve me best of all?

The answer is the Type "K" Valve

Type "K" designates a double disc Gate Valve, unrivalled in design, unequalled in operation.

JENKINS BROS.' Type "K" Brass Gate Valves

Designed and made primarily for the man who wants Efficient Service under Extraordinary Circumstances.

JENKINS BROS., LIMITED
103 ST. REMI STREET :: MONTREAL

Jenkins Bros. Limited
103 St. Remi St.
Montreal

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Name .....

Address .....

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why not adapt your plant to cope with these conditions.

GALT SPRINKLER STOKERS

will efficiently burn the cheapest grades of coal, including the screenings from anthracite, bituminous and lignite fuels, and if used in conjunction with a modern, automatic turbo-blower will double the capacity of your boiler should that be necessary.

It will profit you to write us now—a post card will do. Ask for new 40-page catalog.

The Galt Foundry Co., Galt, Ontario

ALBERTA
W. J. Yeo & Co., 210 McLeod Block, Edmonton

MONTREAL
Ross & Greig 421 St. James Street

OTTAWA, ONT.
Campbell Steel and Iron Works, Ltd.

THOMAS ELLIPTIC GRATE BARS—

SHAKING
CIRCLE
STATIONARY

Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

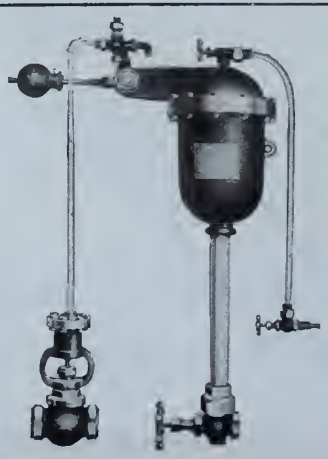
It may never happen to you—but are you SURE it WON'T?

Accidents due to high and low water are occurring continually. Your plant may never suffer, but have you assurance that it won't? Have you taken the necessary precautions against this danger?

The Vigilant Feed Water Regulator is guaranteed to keep water level within ¼" of middle gauge. It is a positive prevention of dangers arising from high or low water.

Investigate it to-day!

The Chaplin-Fulton Manufacturing Company
28 Penn Avenue - - Pittsburgh, Pa.



Commutator Truing Device

Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

JORDAN BROS., INC.

82 Beekman Street - - New York City, N.Y.

Canadian Representative:
CANADA SALES CO., 183 Church Street, Toronto, Canada

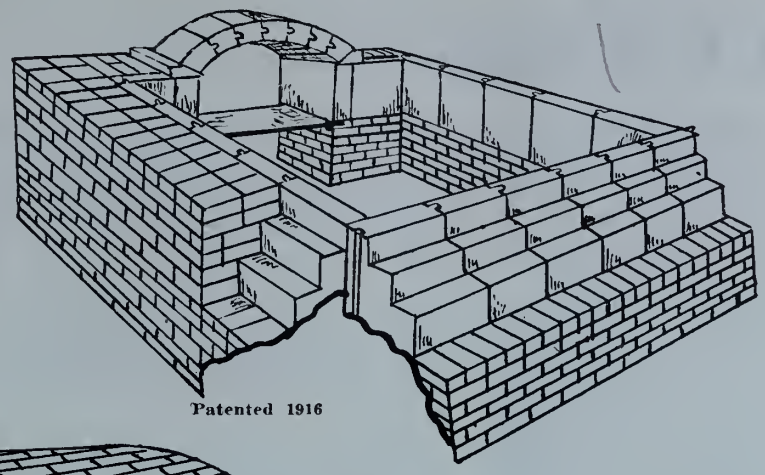
Mention this paper when writing advertisers. It will identify the proposition about which you require information.

Gates Boiler Furnace Lining

Agent for Quigley's "Hytempite" Furnace Cement

Partial List of Users:

Canada Boxboard Co., Ltd.
Dominion Oilcloth Co., Ltd.
Imperial Tobacco Co., Ltd.
Borden Milk Co., Ltd.
Ames, Holden, McCready, Ltd.
Montreal Warehousing Co.
John McDougal Co., Ltd.
Berliner Gramophone Co.
Marx & Rawolle, of Canada.
Sadler & Haworth Co.
Daoust & Lalonde, Ltd.



Patented 1916

Agent for Turner's Plastic Lining

Partial List of Users:

Canada Iron and Tube Co., Ltd.
Dominion Mahogany & Veneer Co.
Daly & Moran, Ltd.
Y.M.C.A. Building, Montreal.
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Dufresne & Locke, Ltd.
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St. Paul's Hospital.
Energite Explosives Co.
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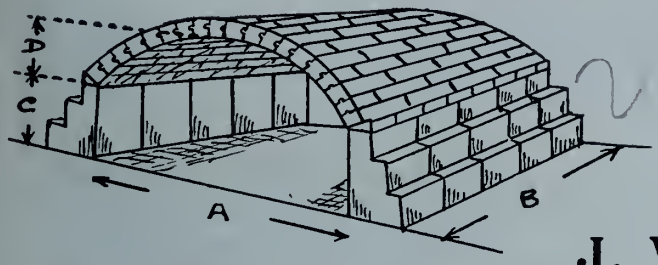
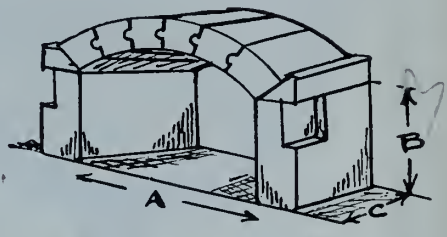


Gates Dutch Oven and Stoker Arch.

Partial List of Users:
Northern Electric Co.
Canada Starch Co., Ltd.
Berliner Gramophone Co.
Dominion Mahogany & Veneer Co.

J. W. Gates

382 St. James St.
Montreal



Gates Boiler Door, Arch and Jambs.

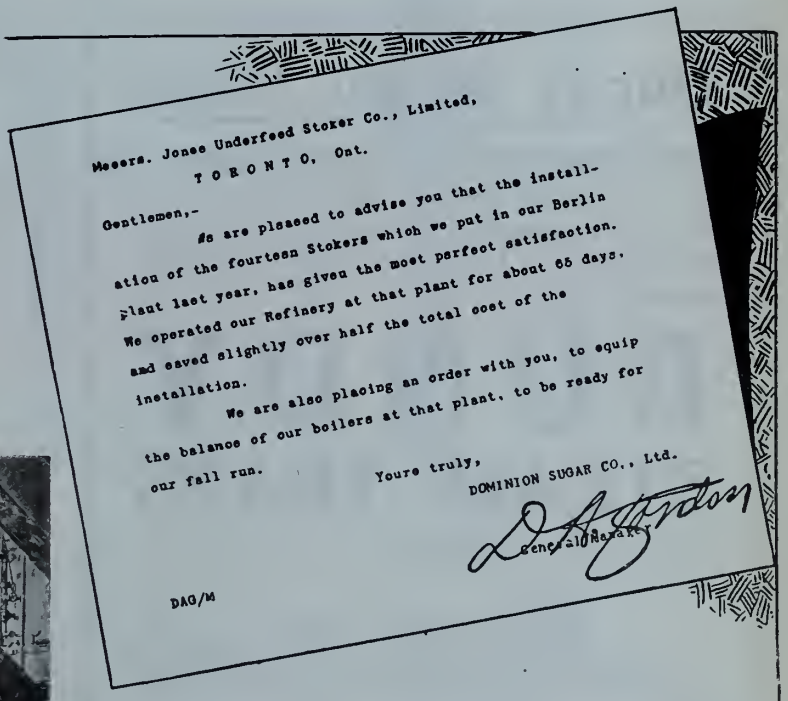
Partial List of Users:
Empire Oil Co., Ltd.
Charlemagne Lumber Co.
Wm. Davies Company.

Jones Underfeed Stokers make big savings—

The installation as illustrated below (14 Stokers) has paid over half its cost in 65 days.

READ THE LETTER

DOMINION SUGAR CO., LTD., KITCHENER, ONT.



Messrs. Jones Underfeed Stoker Co., Limited,
TORONTO, Ont.

Gentlemen,-

We are pleased to advise you that the installation of the fourteen Stokers which we put in our Berlin plant last year, has given the most perfect satisfaction. We operated our Refinery at that plant for about 65 days, and saved slightly over half the total cost of the installation.

We are also placing an order with you, to equip the balance of our boilers at that plant, to be ready for our fall run.

Yours truly,
DOMINION SUGAR CO., Ltd.
General Manager

DAG/M

Simplest stokers built; no parts moving in contact with the fire; no grates; no losses through bars; no smoke.

A big paying investment for the large or small plant. Hundreds of them are effecting savings from 15 to 25% in plants like your own.

Write for catalog.

Jones Underfeed Stoker Co., Limited

37 - 41 Britain Street - TORONTO.

If any advertisement interests you, tear it out now and place with letters to be answered.

PEILER'S SERVICE—

THE simple matter of buying goods at one price and selling at another never made a successful business. The ***Element of Service*** is what adds permanence to any organization, and the success of such organization, is measured only by its ability to serve. The factor of ***SERVICE***—to the customer—always has been, and is, what has guided us in making connections with manufacturers of power plant specialties.

WE have had many years' experience solving difficult power plant questions, of all kinds and conditions, and the benefit of this experience is yours in dealing with us. If your conditions are not suitable for equipment supplied by us, we do not hesitate to advise what we think will overcome your difficulties.

ON this, and the opposite page, a few of our lines are shown. In our opinion, after long experience, with many tests and trials, they are the best, will stand up the longest, and give the most efficient service, of any that are made on the continent.

We solicit your enquiries.

H. L. Peiler & Co.
311 Kent Building, Toronto, Ont.
380 St. James St., Montreal, Que.

Bundy Steam Traps

When you get heat into water, keep it there! Keep it there and hold it there as long as possible, no matter where the water goes. This is the idea which the makers of the

BUNDY
STEAM TRAPS

have been driving home to power plant men for years.

BUNDY STEAM TRAPS
combine Power, Simplicity and Efficiency

Nashua Machine Company
Manufacturers
Nashua - New Hampshire

H. L. PEILER & CO.
380 St. James Street - - Montreal
Are Our Agents in Canada

MASON
Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

CANADIAN AGENTS
H. L. PEILER & CO., MONTREAL and TORONTO

WHY

worry because you cannot keep up steam pressure

WHEN

it is so easy and cheap to overcome your difficulties by installing a

COPPUS TURBO BLOWER

It means constant steam pressure, regardless of uneven loads, poor draft and poor coal, and it will pay for itself in a short time on account of better combustion. It also will increase your boiler capacity to 200, and even 300%, of its normal rating without injury to the boiler. Cut out this Ad., put your name and address on the margin and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

in boilers equipped with Coppus Turbo Blowers in four years.

The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company

167 Union Street, Worcester, Mass.

Montreal Sales Agents:

H. L. Peiler & Co., Montreal and Toronto.

The Power Plant Equipment Co., Toronto, Ont.

BAWDEN NEVER SHORT STROKE PUMPS

BAWDEN

General Service Pump

NO Tappets. NO External Valve Gear Levers or Springs. NO Internal Tubes or Stuffing Glands.

Construction is of very best throughout.

The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

Drop a card for full particulars.

The Bawden Machine Co., Ltd.

133 Sterling Rd., Toronto, Canada

Agents for Quebec:

H. L. Peiler & Company, Montreal, Que.

"REFORM"

Mercury Actuated Dial Thermometer

The reading convenience of a dial face.

The accuracy and sensitiveness of the glass tube thermometer.

Steel construction throughout, combining durability with accuracy and convenience.

Equipped with bottom or back rigid connection and any length stem.

Also with flexible connection like our "Columbia" Recording Thermometer.

Adapted for indicating Feed Water, Condenser, Economizer, Flue Gas Temperatures, etc.

Ask for Pamphlet W-101

THE Schaeffer & Budenberg MFG. CO.

Makers of "Columbia" Recorders, "Crescent" Thermometers, S & B Gauges, Tachometers, Counters, Calorimeters, Indicators, etc.

Berry and South 5th Streets, Brooklyn, N. Y.

Also Chicago, Philadelphia, Pittsburgh.

If any advertisement interests you, tear it out now and place with letters to be answered.

MECHANICAL REFRIGERATION

Scientifically applied means increased returns to the user, in all branches of trade.

We Specialize in this one line. Ask for particulars.

THE LINDE CANADIAN REFRIGERATION CO, LIMITED

37 ST. PETER ST. MONTREAL

Established and manufacturing in Canada, since 1896.

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones. AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada.

CORLISS and POPPET VALVE ENGINES.

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

Keeping Up to Standard

Are you able to operate your Plant to full capacity all the time?
Are you able to always keep your product up to standard?
If not, MECHANICAL REFRIGERATION will probably help you as it has helped many Dealers in your line who are now using YORK REFRIGERATING APPARATUS.

Write us about your conditions. We will be frank to tell you whether a Refrigerating Plant would prove a profitable investment for you. We have no desire to make a sale at the expense of your good-will.

We have helped others, we feel sure we can help you.

YORK QUALITY and YORK SERVICE is the combination that is constantly making new friends for us.

Represented in the Dominion by

CANADIAN ICE MACHINE CO.
MONTREAL TORONTO WINNIPEG
626 Coristine Bld. 62 Chestnut St. 85 Lombard St.

York Manufacturing Co.

(Ice-making and Refrigerating Machinery exclusively.)

YORK, PA., U.S.A.

How Long Does Your Cold Pipe Covering Last?

The life of any cold pipe covering in service depends almost entirely on its ability to resist moisture. If it is not moisture-proof, the water vapor in the air will work into it, become chilled, then condense and deposit moisture right in the heart of the covering. In a short time the insulation will be completely saturated. This not only renders it practically worthless as a heat insulator, but necessitates extensive repairs in a very few years.

On the other hand,

Nonpareil Cork Covering
For Cold Pipes

will last almost indefinitely, with very little attention. The clean, granulated cork of which it is composed does not take up moisture by capillary attraction. Furthermore, each granule of cork is coated with the natural water-proof gum by the manufacturing process. As an additional safeguard against the entrance of moisture, Nonpareil Cork Covering is coated inside and out with a mineral rubber finish, and the joints are sealed with water-proof cement.

Nonpareil Cork Covering has been on these lines for more than six years, with no apparent depreciation. Union Meat Company, San Antonio, Texas.

Full information regarding Nonpareil Cork Covering is given in a well-illustrated 64-page book which, together with a sample of the covering, will be sent, free of charge, on request.

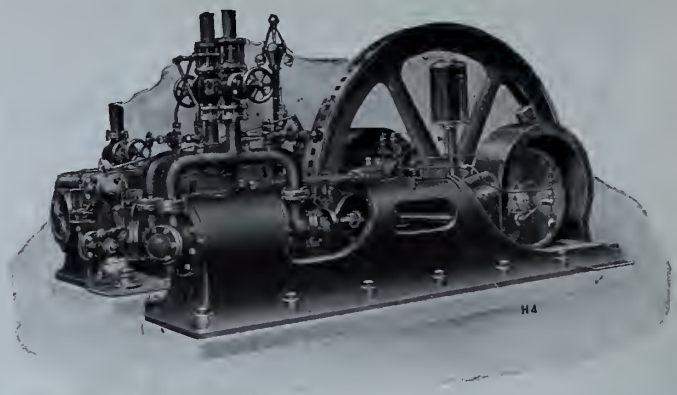
Why not write for them to-day?

Armstrong Cork & Insulation Co., Limited
504 McGill Bldg.
Montreal, Que.

Also manufacturers of Nonpareil Corkboard for all cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings, furnaces, etc.; Nonpareil Cork Machinery Isolation for noisy machinery; and Circle A Cork Brick for cold storage room floors.

If any advertisement interests you, tear it out now and place with letters to be answered.

The Season's Run



means a successful run, when the plant is Built by "Frick" the builders of the

MAXIMUM Economy-Endurance

Ice Making Machines for 35 years.

Hundreds of them are proving this every season.

Write us your needs.

Frick Company

WAYNESBORO, PA. U. S. A.

ICE MACHINERY SUPERIOR SINCE 1862

Canadian Representatives: Frick Ice & Refg. Co., Montreal, Canada

DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because :

1st—Only the best materials are used in their construction.

2nd—We use heavier materials. Result: Longer life and increased efficiency.

3rd—Our doors are built with double and triple seals of contact—others have but one.

4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.

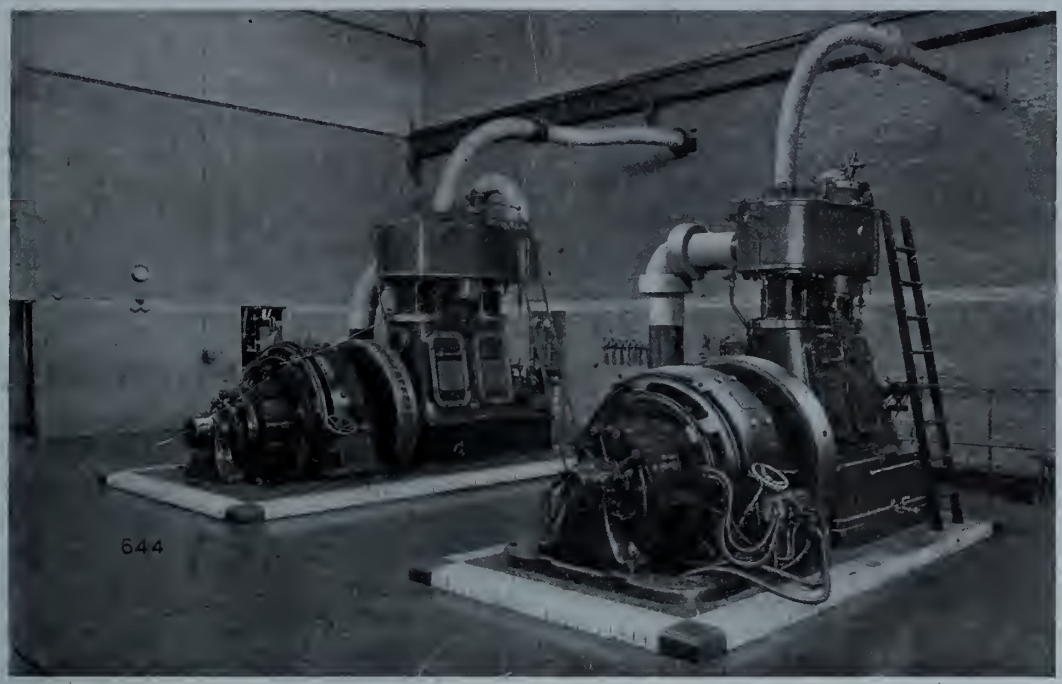
5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

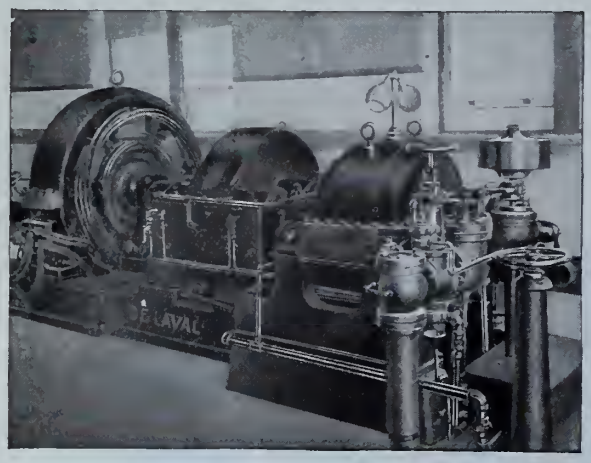
Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: MONTREAL



1200 K.W. geared direct-current generator installed at Trenton Filtration Plant, Trenton, N.J.

The Way to Generate Direct Current

Connect a standard-speed, direct-current generator, which operating men understand and can repair upon occasion, to a De Laval Steam Turbine by means of a De Laval Double-helical Speed-reducing Gear. You thus eliminate all complications and cost of transformers and rotary converters or motor generators, and secure the maximum efficiency of conversion from steam power to electric power, viz., 98½% or over. The turbine can operate on high pressure steam, exhausting to condenser, feed water heater, heating or drying systems, etc., or it can operate upon the exhaust of other units, utilizing steam that would otherwise go to waste and increasing the power output without additional consumption of fuel or the installation of more boilers.

All De Laval units are guaranteed as to efficiency and capacity and are thoroughly tested before they leave the shop. All parts subject to wear are made on an interchangeable basis to limit gages. Moderate stresses, low peripheral speeds, ample clearances and the best materials and workmanship insure reliability.

State steam and exhaust pressures, voltages and kw. capacity required, and ask for special booklet D 61.

DE LAVAL

STEAM TURBINE COMPANY

TURBINE EQUIPMENT CO., LIMITED,
Canadian Pacific Bldg., TORONTO, Canada.
THE E. LAURIE CO., 243 Bleury Street,
MONTREAL, Que.

251

Darling Bros. Limited

The big Steam appliance Organization

OUR PRODUCT:

Heating Appliances
Air Washers
Steam Pumps
Air Compressors
Power Pumps
Electric Pumps
Centrifugal Pumps
Bilge Pumps
Feed Water Heaters
Hot Water Heaters
Hot Water Generators
Feed Water Filters
Receiving Tanks
Pressure Reducing Valves
Back Pressure Valves
Oil Extractors
Steam Separators
Grease Traps
Steam Traps
Exhaust Heads
Blow-off Tanks
Pipe Bends
Expansion Joints
Pump Governors
Damper Regulators
Tank Regulators
Dirt Strainers
Air Traps
Air Line Valves
Pressure Gauges
Lubricators
Water Columns
Oil Filters
Valve Reseating Machines

IF YOU HAVE TROUBLE WITH ANYTHING IN YOUR PLANT, TELL DARLING BROS.

They'll show you how to stop it.

Ask for Catalog on the line or lines in which you are interested.

Head Office and Works:
MONTREAL

TORONTO **WINNIPEG** **VANCOUVER**

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

CANADIAN AGENTS

A. R. Williams Machinery Co., Toronto.
Williams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company
Battle Creek, Mich.

American-Marsh Centrifugal Pump.

Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

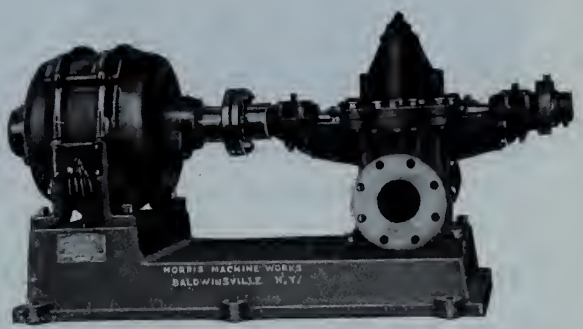
Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

Regulating Valve Placed at Any Point, Any Position.

The "S-C" Regulator Company.
Feed Water Regulation Engineers
FOSTORIA, OHIO, U.S.A.

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2" to 20" discharge.

Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.
Builders of Centrifugal Pumps, Hydraulic Dredges, Steam Engines

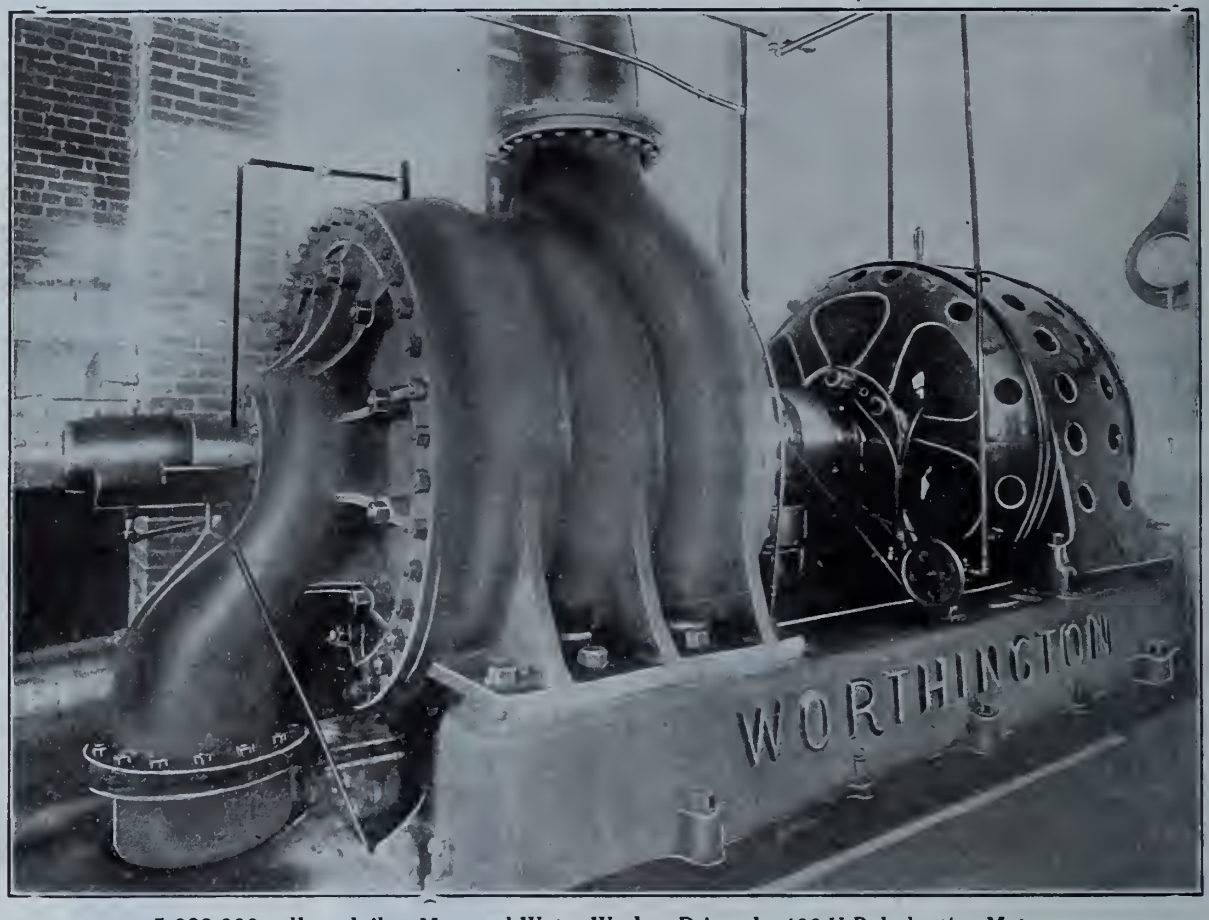
Canadian Sales Agents:
Storey Pump & Equipment Co., Toronto, Can.

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works : Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO March, 1917

Link-Belt's Tribute to Trade Papers

By JULIUS S. HOLL,*

Extract from an interesting article appearing in "Class."

[Editor's Note:—The conclusions of the head of the promotion department of one of the most consistent trade and technical journal advertisers in the country on the subject of the value of this advertising is not "snap judgment," but is based on experience obtained through the expenditure of approximately $100,000 a year. The appropriation, be it noted, has been increased only as results have justified it, and the company is now using bigger space, more mediums and more trade paper advertising generally than ever before.]

THE trade paper is the manufacturer's best medium for exploiting his product.

It is the most inexpensive kind of advertising, because it keeps the message of the manufacturer before buyers in his field all the time for a nominal sum, and with comparatively little trouble involved in the preparation of the copy.

We get direct returns, yes—but we do not consider the "inquiry" the real index to the value of the advertising or the trade journal. It is a far bigger, better thing than that.

The big idea back of our advertising is to create confidence in our products, to make the buyer want what we have; to do constructive, educational advertising of Link-Belt products and Link-Belt service.

In our Chain advertising, for instance, our copy is designed to show the many varied uses of this product in the field of power transmission. Our aim is to make the purchaser think of Silent Chain when he connects up new machinery. The point I am trying to make is that we are endeavoring to do a constructive, educational kind of advertising, and that our policy has been successful in bringing results.

We realize that getting results from advertising is not a matter of running one or two or half a dozen ads. Constructive advertising takes time. Any man who starts advertising in a trade journal a staple product which does not possess startlingly new or sensational features, should realize that it will take time to get the desired results; but these results are worth waiting for. As John Wanamaker says, "Advertising doesn't jerk, it pulls."

It begins very gently at first, but the pull is steady. It increases day by day and year by year, until it exerts an irresistible force. This is particularly true of trade journal advertising.

Our sales forces are in absolute harmony with our advertising policy, a vital asset to any advertising department. One of our salesmen, who handles the clayworking trade, which is a big user of Link-Belt Silent chains, declared at a recent sales conference that the effect of our advertising in *Brick and Clay Record* in popularizing Link-Belt Silent Chains with the brick manufacturers has been largely responsible for our success in this field, and declared further that if trade papers in other fields were giving similar results, then the trade journal method of advertising was a great success.

Because we have more and more realized what the trade journals can do for us, the tendency has been definitely in the direction of large space. We formerly used comparatively small space, quarter and half pages, but now we seldom run anything less than a full page. Each ad. is carefully built, the foundation usually being a photograph of an installation in the field to which we are advertising, so that every picture tells a story of interest to the readers in that particular industry. It keeps us hustling to dig up these pictures, and to get photos of the right kind, but that makes the sort of publicity that gets the interest of the reader, because the ad. talks to him in his own language.

Our advertising is adapted to meet the condition of each industry. Our products also are too varied to permit of comment upon each; but the value of the trade journal is clearly illustrated again in our advertising in the coal mining industry. Seven years ago we used card space, with an occasional half-page "splurge," yet the volume of business received was satisfactory to our house.

* Advertising Manager, The Link-Belt Company, Chicago

THE POWER HOUSE

143-153 University Avenue - Toronto

POWER EQUIPMENT

ENGINES

BOILERS

2-G. & McC. Sectional Water-Tube Boilers at St. Boniface Hospital, Winnipeg, Manitoba.

CONTINUOUS SERVICE *in your power plant means* — UNINTERRUPTED PRODUCTION

and in these days of rush, such production is of the greatest importance. The prime factors in this continuity of operation are your ENGINES and BOILERS. G. & McC. Co. Power Equipment is designed and built as a means to supplying this

MUCH-TO-BE-DESIRED CONTINUOUS AND ECONOMICAL SERVICE

Catalogs, Plans, etc., will be mailed to those interested upon request.

THE GOLDIE & McCULLOCH COMPANY, LIMITED

Head Office and Works - - - - - GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

Domestic Water Filtration Plant, City of Montreal, P.Q.

Staff Article

Pollution of water supply for domestic purposes is more or less incidental to every community in which growth and development are in progress, but to a greater degree when these elements are at one and the same time rapid in their movement and extensive in the matter of territorial scope. In our older established cities particularly, a stage is usually reached at which the public health is menaced by reason of impure water for domestic purposes.

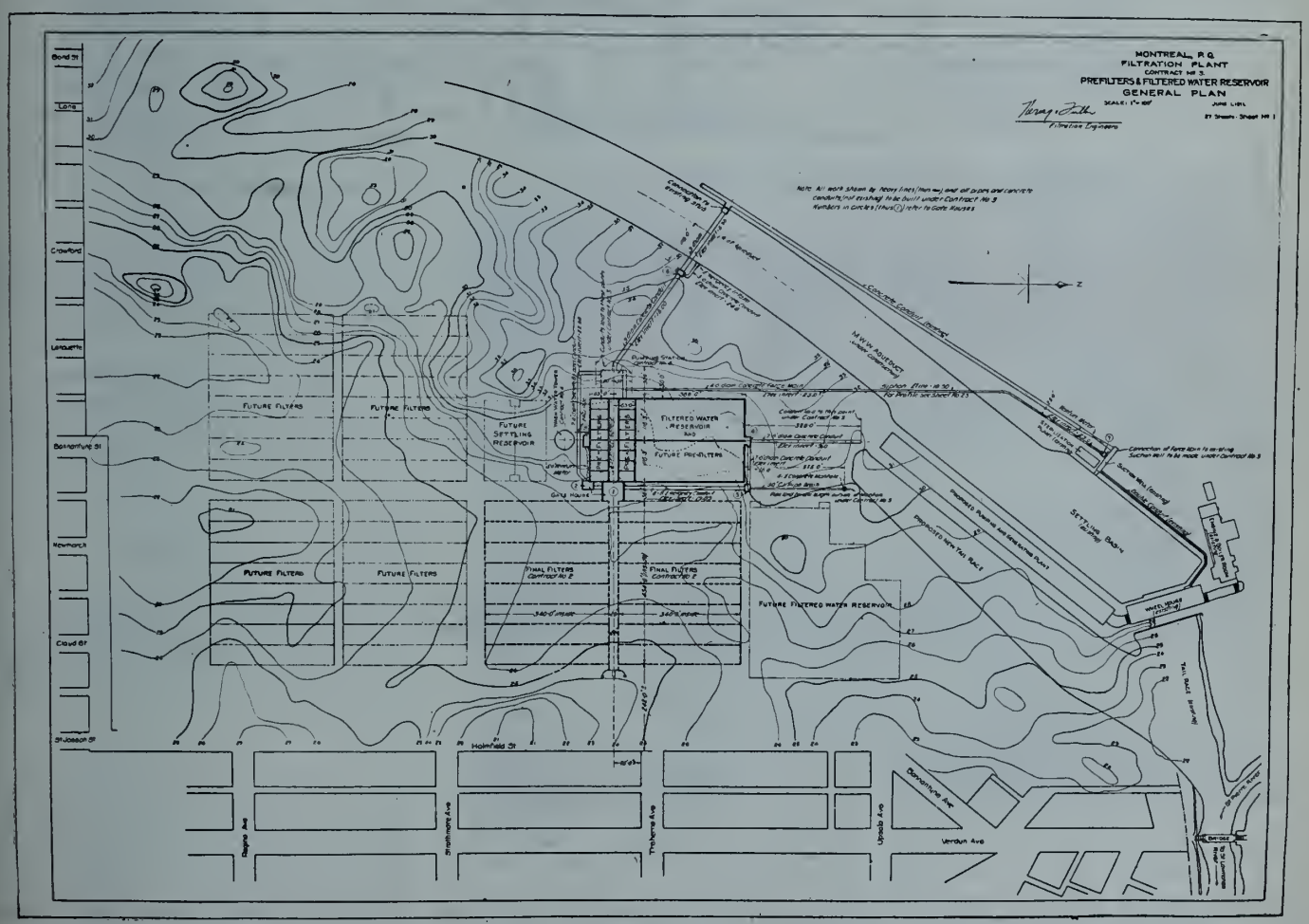
THE present water supply of the City of Montreal is obtained from the St. Lawrence River, and is distributed to consumers by two independent bodies—the Montreal Water & Power Co., a private corporation, and by a municipal waterworks plant. The former concern takes its supply from off the river shore, and since the middle of 1912 the water has been purified by means of a mechanical filtration plant. About one-fourth of the entire city population is numbered among its customers. The water supply for the municipal plant is taken from the river about five miles up stream, above the Lachine Rapids; two intakes are provided—one close to the shore and the other in mid-stream. From the entrance gate, which is common to both intakes, the water is delivered through an 8½ feet concrete conduit, to the main or low level pumping station; this plant delivering the water to the reservoirs and city mains. The average quantity of water passing through this station is approximately 55 million gallons per 24-hour day.

Initiation of the Project

Owing to the increasing pollution of the water supply in the river, caused by the growth and development of the surrounding districts and the additional population contingent to same, it was deemed advisable, if not absolutely necessary, to instal some means of purification, to aid in combating the fever epidemic that was prevalent during the fall and winter of 1909. In February, 1910, the water supply was subjected to treatment by hypochlorite of lime, this practice having been continued up to the present time. However, while the authorities were reasonably well satisfied with the results obtained from this process, steps were taken to provide a more efficient and improved water supply for the city use, and in April, 1910, Messrs. Hering & Fuller, filtration engineers, were instructed to report on the best means of securing this objective. Some few months afterwards the report was submitted and subsequently adopted, the above-mentioned engineers being engaged to co-operate with the late Major Georges Janin, then chief city engineer, in the preparation of specifications and plans for the construction of filtration works for the municipality.

General Features

The source of water supply for the operation of this system is the same as that already mentioned; that is, the intake about five miles up the river, but it is delivered to the filtration pumping station through a nine-foot concrete conduit, which taps the present supply pipe of the low level pumping station. The connection is made at the nearest point to the filtration pump house, and in addition to this supply, facilities have been provided for an emergency intake from the aqueduct, now in course of construction. This last-mentioned alternative,

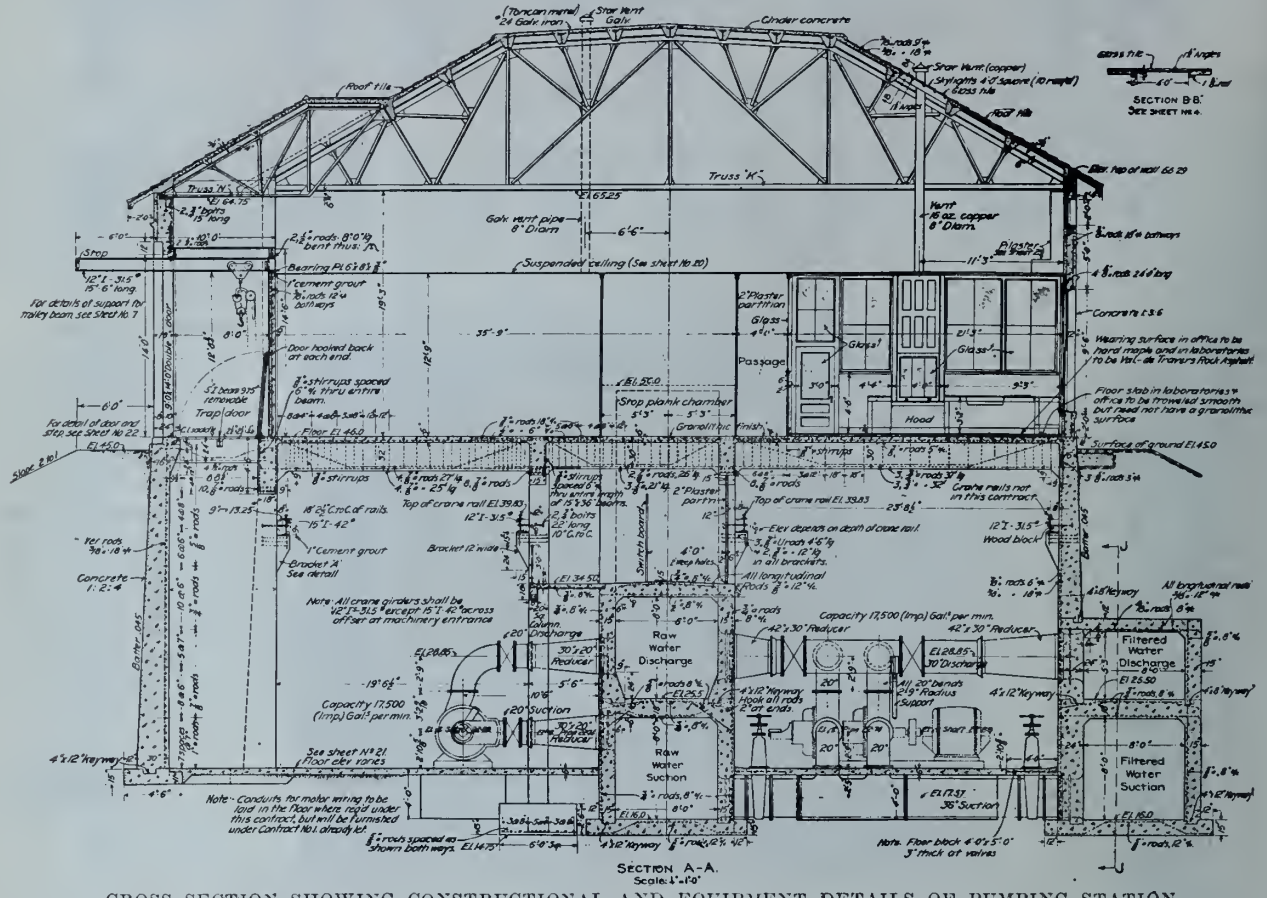


GENERAL PLAN OF FILTRATION WORKS, SHOWING PRESENT INSTALLATION AND FUTURE EXTENSION PROVISION.

however, will only be used when the main supply conduit is out of service, or additional water consumption necessitates increased capacity, as the waters of the aqueduct will naturally contain a higher percentage of impurities. The purpose of the filtration pumping station is to elevate the raw water in the supply conduit to the pre-filters, a height of approximately 18 feet, and also to furnish water at a higher pressure for washing and cleaning the pre-filters; the supply for this purpose being pumped into a large tower located outside of the main building. After passing through the pre-filters, or first and rapid stage of the purification process, the water flows by gravity through closed conduits to the final or slow sand filters, from which it passes to the filtered water reservoir, located north of and below the pre-filter beds. If deemed advisable, additional purification may be made at this point, but it is generally believed that little chemical treatment will be found necessary. Under the present system, the water from the filtered reservoir will again pass to the filtration pumping station and be pumped to the low level station, from which the high pressure pumps will force the water to the city distributing service.

With the completion of the aqueduct, now under construction, and the operation of the proposed Hydro-Electric pumping station, the filtered water will not return to the filtration pumping house, but will flow by gravity from the reservoir to the pumps in the Hydro-Electric station.

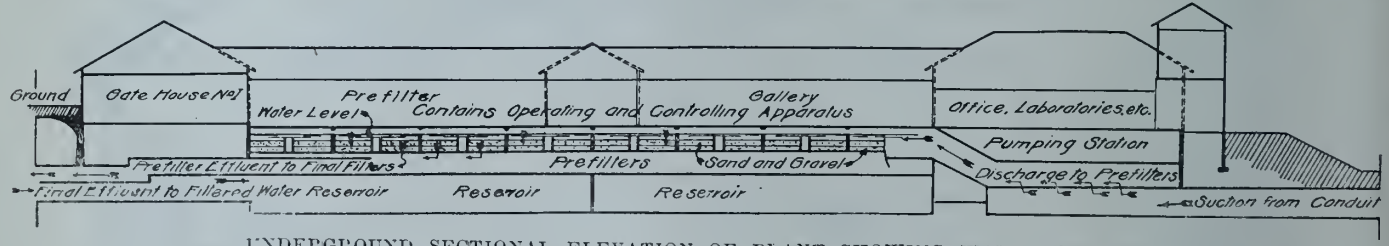
At the time the original plans were being prepared in 1910, the filtration works were designed for a nominal daily capacity of about fifty million gallons per 24-hr. day, being one-third greater than the quantity of water consumed at that time. It was, however, realized that additional filtering facilities would be required for the larger consumption of water contingent with the ever increasing population; so, with this in view, ample property was acquired in the immediate vicinity to allow for future extensions to the present plant. The remarkable growth of the city, together with the annexations of adjoining municipalities, has necessitated such large extensions to the city distributing system that the present plant will require to be operated at full capacity from the day it is put into service. The rapidly growing need of the city requirements is so apparent that steps may soon be taken to enlarge the present filtration plant to provide for a daily capacity of 100 million gallons of filtered water, or even a greater supply.



CROSS SECTION SHOWING CONSTRUCTIONAL AND EQUIPMENT DETAILS OF PUMPING STATION.

Filtration Pumping Station

The filtration pumping station, two partial views of which are here shown, is a two-storey reinforced concrete structure, 80 feet by 60 feet; one section of the pumping house being open for the entire height, with a 5-ton crane traversing the full length above the large pumping units. The top storey of the northern half of the station is reserved for the offices and general laboratories; these latter being equipped with every facility for the complete analyses of the raw and



UNDERGROUND SECTIONAL ELEVATION OF PLANT SHOWING WATER COURSE.

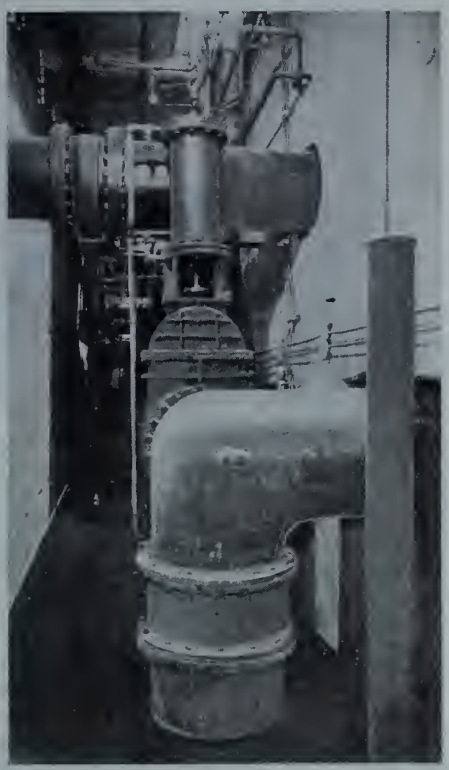
filtered water. Running along the centre of the pumping room is the raw water conduit, divided into two sections, one above the other; the lower being for the suction and the upper for the discharge. The pumping units are so arranged on either side of the lower floor that the water is taken from the lower conduit and discharged into the upper one, with a minimum of piping connections.

Main Pumping Units Layout

As shown in the plan of the pumping station, the units on the south side are connected for the pumping of raw water exclusively, while those on the opposite side of the station are connected to both the raw water conduit and the filtered water reservoir; suitable check and control valves being provided for the operation of the section desired. This method of installation will permit one or all of these units to be used for the delivery of the filtered water from the reservoir to the present low level pumping station, as this system will be necessary until the completion of the proposed hydro-electric station, when the purified water will flow by gravity to the new pumping units. In the operation of the ultimate installation, all the pumps in the present filtration plant, with the exception of the wash water and sump pumps, will be available for supplying raw water to the filters. In order to meet the capacity requirements without the alteration of standard patterns, the six largest pumps were designed with twin suction and discharge connections; all these units are controlled by hand operation. Four of them are of 17,500 gallons per minute, the other two being of 11,600 gallons capacity. The two smaller raw water pumps are of 5,800 gallons capacity, and are automatically operated by means of float switches, which in turn are controlled by the water level in the pre-filters; the pre-determined high level shutting off the power and the switch being thrown in to resume pumping operations, when the water has again fallen to a certain level. These two 5,800 gallon pumps represent about one-tenth of the total pumping capacity of the plant, and under normal conditions either one or both of these units will always be in service. The automatic control of these last-mentioned pumps, for the proper regulation of the water output, is an essential and very important feature in the operaton of the filtration plant. The significance of this can be more clearly shown by an example: For instance, suppose each filter is set to take care of three million gallons per day, or 48 million gallons for the entire plant, it would be impossible to exceed this output without the readjustment of the device controlling the rate of filtration.

Water Supply Control

Owing to the accumulation of foreign matter that will be deposited upon the upper surface of the sand beds, the filters will naturally become clogged and, therefore, will periodically require to be put out of service for a short time to permit of cleaning. When one filter is shut down for this purpose, the volume of water passing through the others is increased at the rate of three million gallons per day, and with the pumping



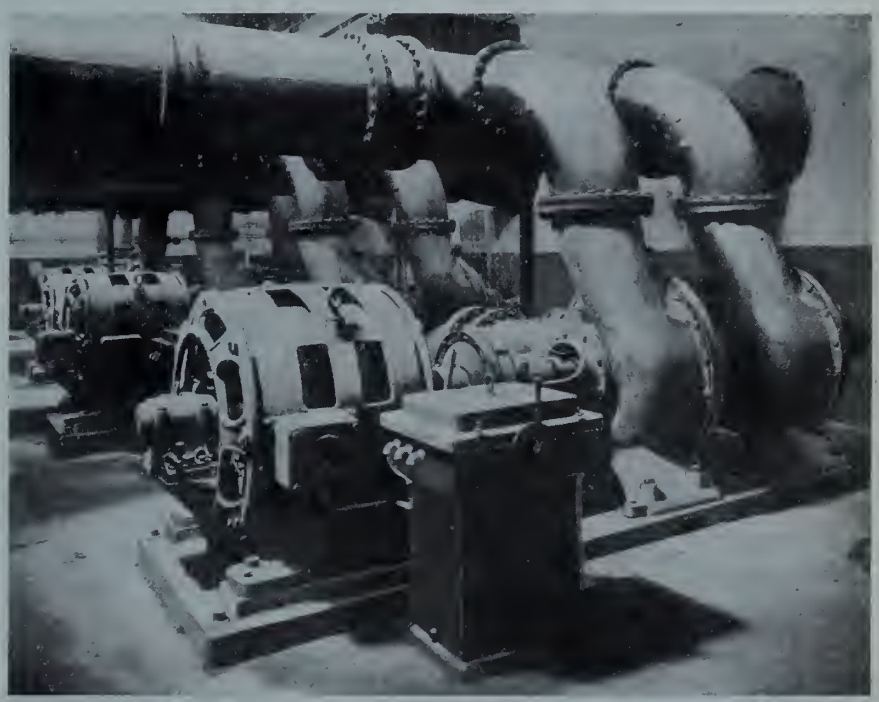
"PRATT & CADY" HYDRAULICALLY OPERATED VALVES IN PUMP GALLERIES.
Stand pipe in right foreground encloses rod from float which automatically controls their operation.

equipment delivering 48 million gallons to the remainder of the beds, the water would soon reach an undesirably high level; for this reason it is absolutely necessary that some means be provided for the control of the supply. After the pre-filter is washed, which may take from ten to fifteen minutes, it is again placed in service, the filtration proceeding at the rate of 48 million gallons per day, which in a short time will lower the level of the water to the point where the controlling float will operate the switch, and the small pump again start to operate. Another feature in connection with this method of control is that the engineer in charge is always advised as to the condition of the filters; so that when one or both of these pumps go out of service, he knows that more water is being delivered to the filters than they can use. If, after investigation, he finds the beds in good working order, he knows that the large pumps are supplying too much water, and regulates them accordingly. Should these pumps be stopped and the water continue to rise above a set level, the engineer is warned by the ringing of a loud gong, automatically started when the water reaches the danger point. This is followed by the engineer shutting down one of the large pumps.

Wash Water and Drainage Pumps

The two wash-water pumps are used to deliver water to the 120,000-gallon tank, located outside the pumping station in the wash-water tower. This supply is for the purpose of washing the pre-filters at time of cleaning; the height of the water in the tank is indicated at all times on a Winslow gauge located in the pre-filter gallery. All the pumping units, together with the blower and crane, were installed by the British Electric Plant Co. of Alloa, Scotland.

In addition to the above, two sump pumps, automatically controlled by float switches, are provided for the removal of seepage and drainage water. Their operation is such that little or no atten-



VIEW OF NORTH SIDE OF PUMPING STATION.
Showing three 17,500 gallons per minute pumps with piping arranged so as to operate on either raw or filtered water.

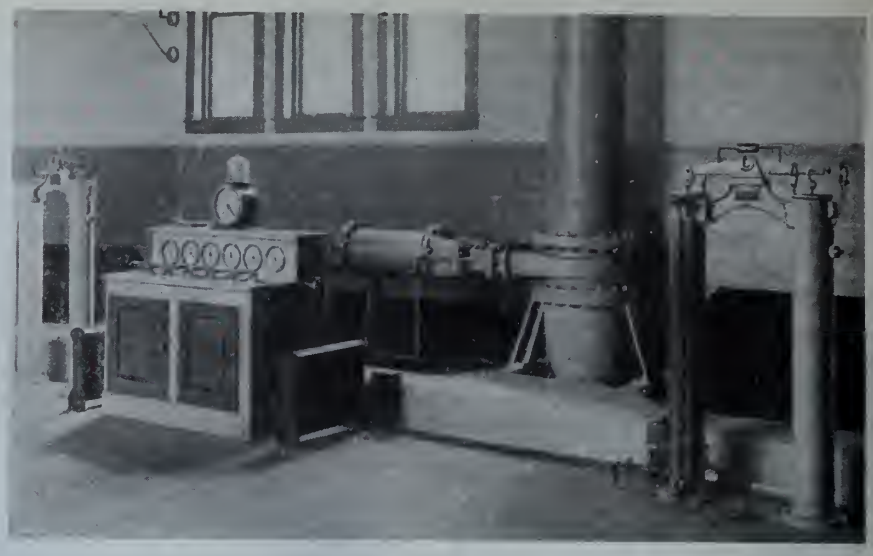
tion is required by the engineer of the station.

Pre-Filters and Control Gallery

Adjoining the east end of the pumping station, and arranged on either side of a central operating gallery are the sixteen rapid or pre-filters, each having a net filtering area of approximately 1,200 square feet. Each pre-filter is divided longitudinally by a central gutter into which empty the sixteen internal reinforced concrete wash-water gutters. The strainer and air system is made up of cast iron headers and 2-inch cast iron laterals with brass strainers spaced on 6-inch centres. The filtering material consists of 15 inches of gravel, graded into four sizes, each grade being capable of supporting the next smaller in size; the bed of gravel being finally covered with 30 inches of filter sand. Below the central operating gallery and throughout its entire length is a large double concrete conduit, the upper section carrying the raw water supply from the pumping station to the pre-filters; the effluent from the filters passing into the lower section of the conduit. These conduits are connected to the pre-filters by cast iron piping with hydraulic controlled valves.

Rate of Filtration Control

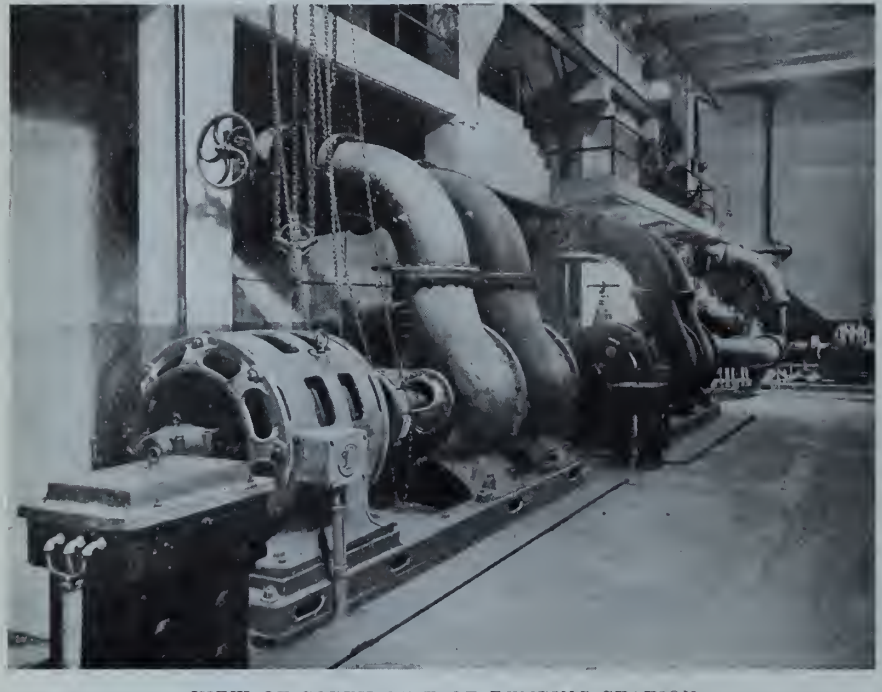
The rate of filtration in each separate pre-filter is governed by an Earl controller, each one being so connected to a master controller that the discharge from the pre-filters is automatically adjusted to that from the final filters, which in turn is again under automatic control by the volume of water that is drawn from the filtered water reservoir. The entire operation of the filtering system is practically automatic in its action, as the filtered water is delivered to the city mains at the same rate as that of consumption, without the aid of man operation of the many controlling valves. These hydraulically operated valves, both on the air and water service are of the Pratt & Cady type, fitted with cylinders of 10 inches diameter and of a length suitable to the size of the valve, the pressure required for operation being from 65 to 75 lbs. per square inch. Several of these valves are shown in the partial view of the control gallery, together with the air supply pipes and the wash water control units. The air supply is obtained from a Roots blower located in the pump room, the pressure available being about 5 lbs., this being sufficient for cleaning two beds at one time, if necessary. This air is used for agitating the sand when cleaning, a pressure of 5 lbs. being ample to overcome the head of water in the pre-filter chamber. In the cut showing the controlling unit, the various details reading from the left are: An individual controller, washing control table, Pratt & Cady hydraulically operated air valve, air supply pipe, and master controller. Two of the electric heaters, typical of those installed throughout the plant, are seen on either side of the wash water table. The various control handles, with their respective gauges, reading from the left are: —Raw water, drain, wash water, air, filtered water waste, and filtered water. The gauge showing the loss of head in feet in each bed is located in the centre by the Roberts Filter Mfg. Co., of Darby, Pa.



ONE OF THE CONTROLLING UNITS SHOWING MASTER CONTROLLER AT RIGHT.

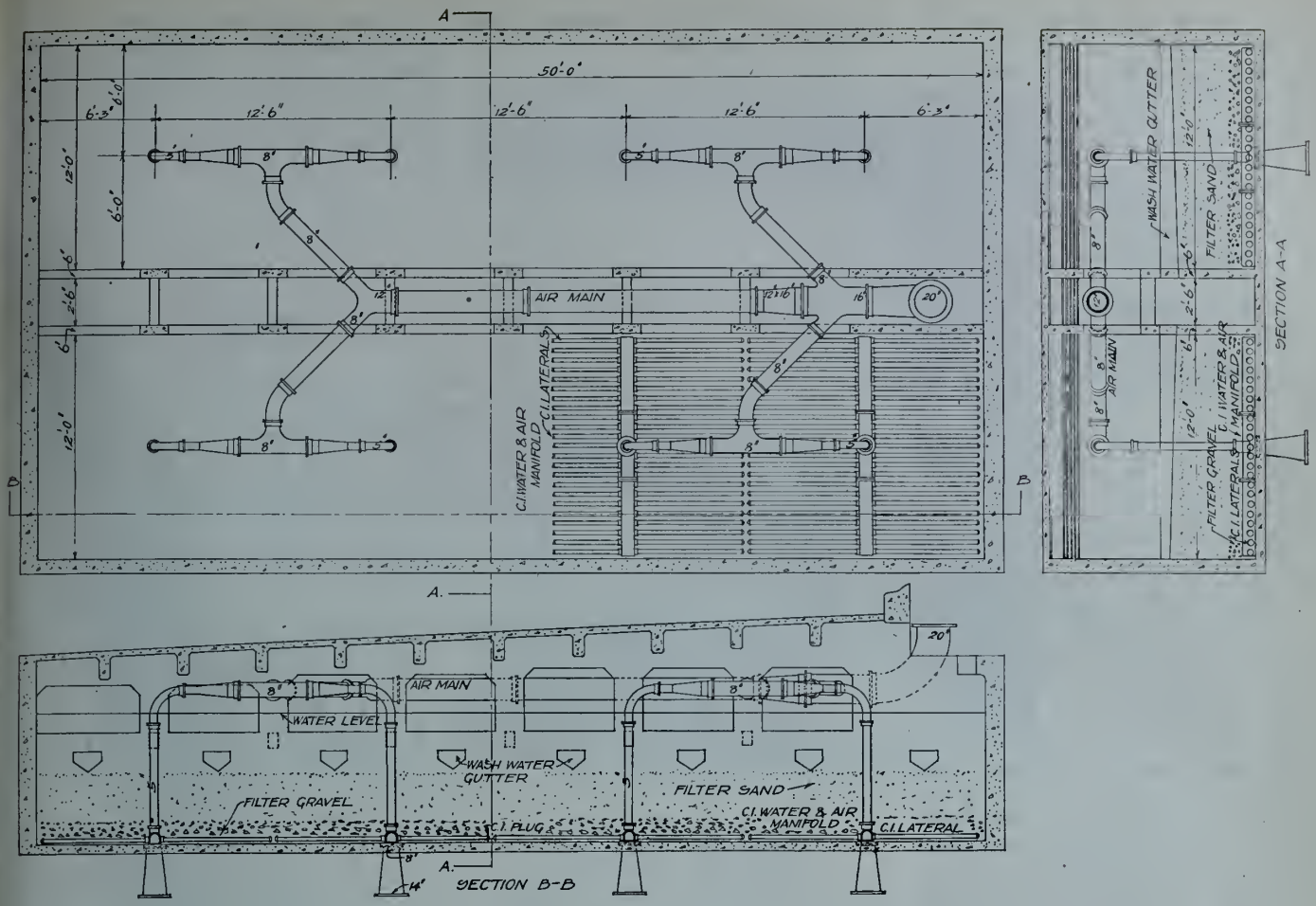
Final Filters and Washing Appliances

The final filters are somewhat similar to the pre-filters and are also arranged, eight on either side of a central operating gallery, but, owing to the slower rate of filtration, they occupy a much more extensive area than the preliminary or rapid filters. Each filter has an inside measurement of 55 by 340 feet, the length being at right angles to that of the central gallery; these filtering beds are covered with concrete-groined arches supported on piers spaced at 19 feet centres. This overhead load is carried on independent foundation blocks below each pier. The floors are flat, of five inches of concrete, and are only required to support the weight of the filtering material and the water therein. On either side of the dividing walls, light rails are provided for the operation of the Blaisdell washing machines when the filters are being cleaned. This process like that of the pre-filters, requires to be performed periodically, the machines traveling over the entire length of the filtering chamber while the upper layers of the sand are raked and washed, the dirt and other impurities that have collected since the previous cleaning being pumped away to the drains. This cleaning process can be accomplished at one passage of the machine, with only one man required

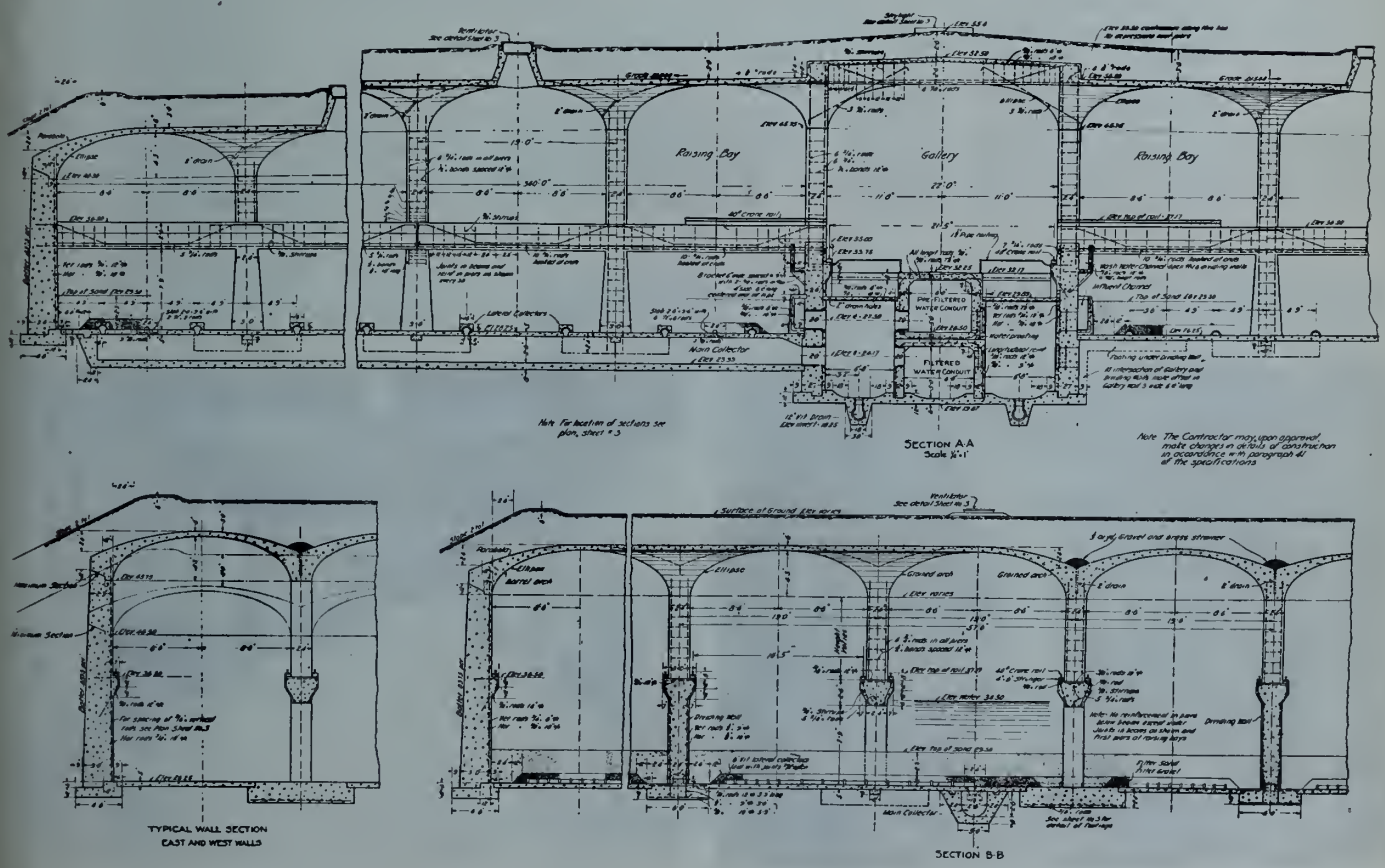


VIEW OF SOUTH SIDE OF PUMPING STATION.

From left to right: Pumping units of 17,500 and 11,600 galls. per min. respectively, and wash water pump of 1,300 galls. per min. Operating switchboard on upper gallery. Motors and pumps supplied and installed by British Electric Plant Co., Alloa, Scotland.



PLAN AND ELEVATIONS OF PRE-FILTER CONSTRUCTIONAL AND EQUIPMENT DETAILS.



VARIOUS SECTIONS ILLUSTRATIVE OF FINAL FILTERS DETAIL.

for its operation, the sand bed being left clean and uniform.

One washing machine is provided for the eight beds on either side of the central gallery and is transferred from one bed to another by means of a traveiling car that operates throughout the entire length of the department. Among the advantages of this method of cleaning are the following:—

Minimum length of time filter is out of service.

Removal of impurities from the sand is more complete than can be accomplished by any hand method, as the cleaning process can be extended to any desired depth below the surface of the sand.

Density of the sand is more uniform, as workmen are not required to walk over its surface.

Operation is more regular during the entire year, with no decrease in the effective filtering areas.

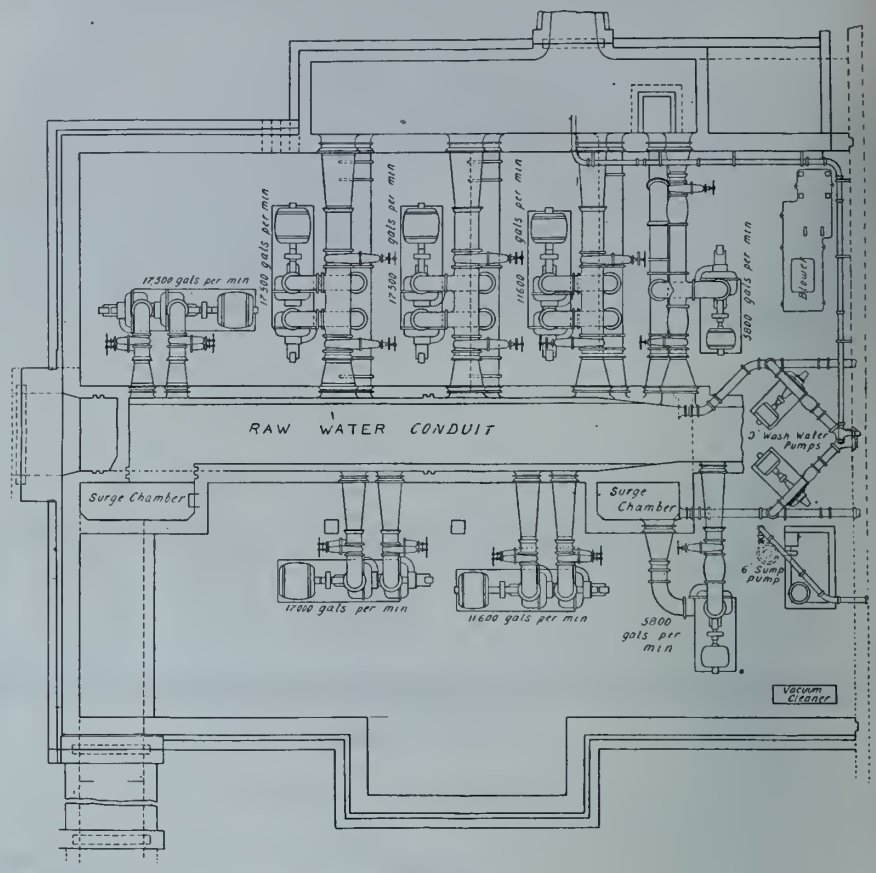
To eliminate the possibility of skin ice forming on the beds during the winter months, a heating and ventilating system has been provided; thus permitting free movement of the washing machines at all times, and in addition making the filters more healthy and comfortable for the workmen. The heating and ventilating equipment consists of a fan and numerous air ducts, these being arranged so that the heated air can be uniformly distributed over the entire area of the filters.

When the water has passed through these filters it enters into a number of half-round 8 inch tile laterals, two in each bay, and is then discharged into a central main collector, 2½ feet in diameter, extending the entire length of the filter chamber and below the floor level. From these collectors the filtered water is carried to the filtered water reservoir —a large concrete chamber about 430 by232 feet in size with an approximate capacity of 6¼ million Imperial gallons. This reservoir is located to the north of and below the pre-filters, and has a groined arch roof with the floors of inverted groined arches. There are no special features in connection with this section of the plant, except that it is employed as the chief controlling unit as already mentioned.

Electrical Operation System

The filtration plant is operated throughout by electrical power, as are also the heating and lighting. Until the completion of the city hydro-electric power and pumping station, referred to previously, the power required will be obtained from the Montreal Light, Heat & Power Co., which has a 10,000 volt transmission line near the plant. By means of branch connections, this voltage will be brought to the filtration plant transformer station where the alternating current will be reduced to 2,200 volts and then transmitted through underground conduits to the filtration buildings. This voltage of 2,200 will be used for the operation of the main pumps, but for the requirements of the smaller units and for lighting, reduction will further be made to 550 and 220 volts respectively. The entire plant will be electrically heated, two of the radiators being shown in one of the illustrations. washing machines, which use direct current, a motor-generator set has been installed to supply power to the machine motors through the three miles of double trolley lines, by which the machines are operated in the final filters.

Viewed from the exterior, the casual



PLAN OF PUMPING STATION SHOWING LAYOUT OF VARIOUS UNITS.

VIEW ALONG COMPLETED PRE-FILTER GALLERY.

VIEW LOOKING ALONG FINAL FILTER GALLERY.

observer would have little conception of the extent of this filtration plant which has a filtering capacity of over 50 million gallons per day. The few red brick buildings with their green tile roofs give but little indication of the vast amount of concrete, filtering facilities, piping and other mechanism that are essential for the successful operation of a modern filtering system. Of the ten acres occupied by the present work, over nine acres, including the final filters, pre-filters and filtered water reservoir, are entirely under ground; the location of the several sections being made known to the initiated by the position of the pumping station, pre-filter gallery building, wash water tower and the several gate houses. It might be stated here that along the roof of the final filter operating gallery are located 22 inverted oblong skylight prisms, all protected from above by means of an iron grating. While the present outward appearance gives one the impression of a few isolated buildings in the center of 100 acres of level ground with a few neatly trimmed slopes, on the completion of the progressive programme now under consideration, which comprises the construction and extension of driveways, the planting of trees and shrubs and otherwise improving the site, the apparently barren present appearance of the landscape will be found to have disappeared converting the property into a spacious park, which will not only be appreciated by the nearby residents, but will also furnish an attractive setting to one of the city's most beneficial public works. The approximate cost of the system is given in the following tabulation.

Pumping machinery, blower and cranes. British Electric Plant Co., $40,250.

Final filters and appurtenances. F. H. McGuigan, transferred to Norman M. McLeod, $673,000.

Pre-filters and filtered water reservoir. F. H. McGuigan, transferred to Norman M. McLeod, $485,000.

Pumping station, wash water tower and buildings. F. J. Jago Co., $159,500.

Interior painting. Charles Larin, $1,250.

Exterior electrical conduit system. G. M. Gest. $6,000.

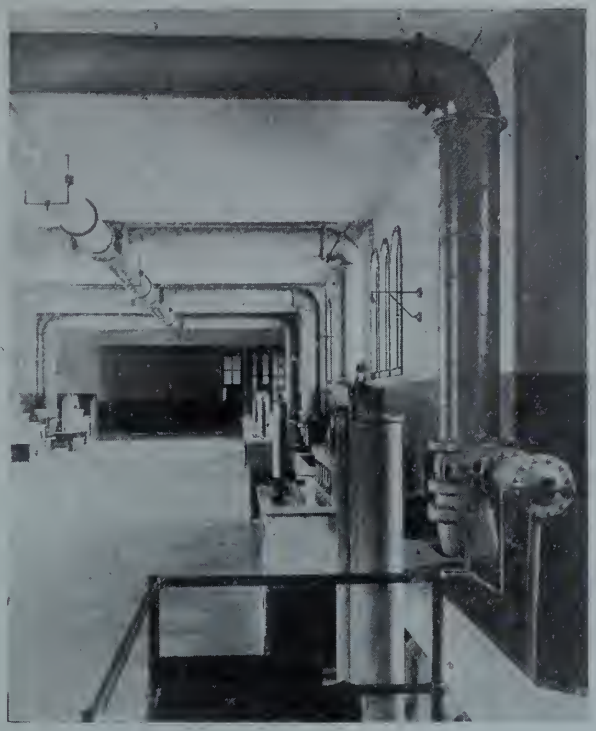
Underground electrical cables and appurtenances. Northern Electric Co., Montreal, $12,500.

Transformer building. City of Montreal, $6,000.

Approximate total value, $1,383,500.

Approximate Total Value

Owing to the great difficulty in securing suitable gravel and sand for filtering purposes, the completion of the work has been much delayed, but the final material is now being installed and it is anticipated that the entire plant will be in operation before the spring. The filtration works and other waterworks improvements are being carried out under the general supervision of Messrs. Paul E. Mercier, chief engineer of public works, and T. W. Lesage, engineer superintendent of water works, City of Montreal.



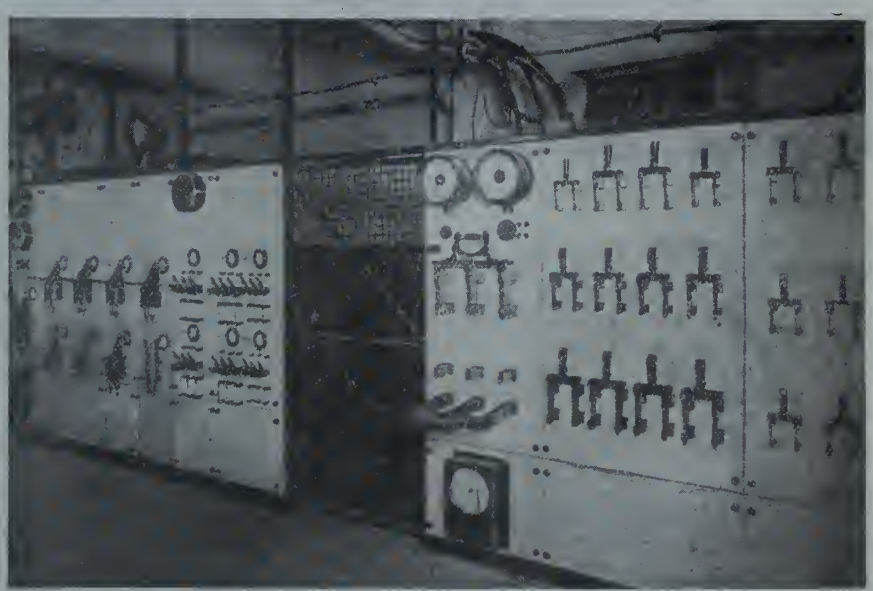
PART VIEW OF CONTROL GALLERY.

AN EIGHTEENTH CENTURY PUMPING ENGINE

IN a recent paper before the Institution of Mining Engineers, England, the authur W. T. Anderson referred to an engine which was installed at the Gregory mine, near Ashover, in 1774. The accompanying illustration of the engine is photographically reproduced from an original drawing made by Francis Thompson, and still in the possession of J. B. Gregory, of Ravensnest. The document is inscribed "Multum in Parvo by Fr. Thompson, 1774—A Draught of the fire engine at Gregory's Mine. Near Ashover." The description, with its somewhat quaint original spelling retained, is given below, for which, and the illustration, we are indebted to *The Engineer*.

Whether Thompson at this time was a representative of the manufacturers, or was the actual designer, is not clear. He may have been both, especially as it was a custom of the period to pay for machinery by result, either in the form of a percentage on the quantity of minerals raised, or on the number of strokes recorded. It has been suggested that Thompson's 1774 engine was manufactured by Boulton & Watt, but this, Mr. Anderson thinks, is more than doubtful, as Watt did not go to the Soho Works until that year, the patnership between the two eminent engineers being arranged in 1775. The machine also was of earlier design than their standard type —without a separate condenser. It seems, however, that a few year later, namely, in 1782, heavy disbursements were made by the Gregory Co., to both Thompson, and to Boulton & Watt, probably in connection with a new engine and pump shaft. A certain association between the three men may therefore be considered established. An entry in 1768, is of peculiar interest: "Mr. Brindley, engineer, demands for his trouble at Gregory, £4 4s. 0d."

A Description of the Engine for Raiseing Water by Fire; whose Cylindor is 42½ in. Diameter, and raises the water 61 yards a 12in. Boar.—Now, to



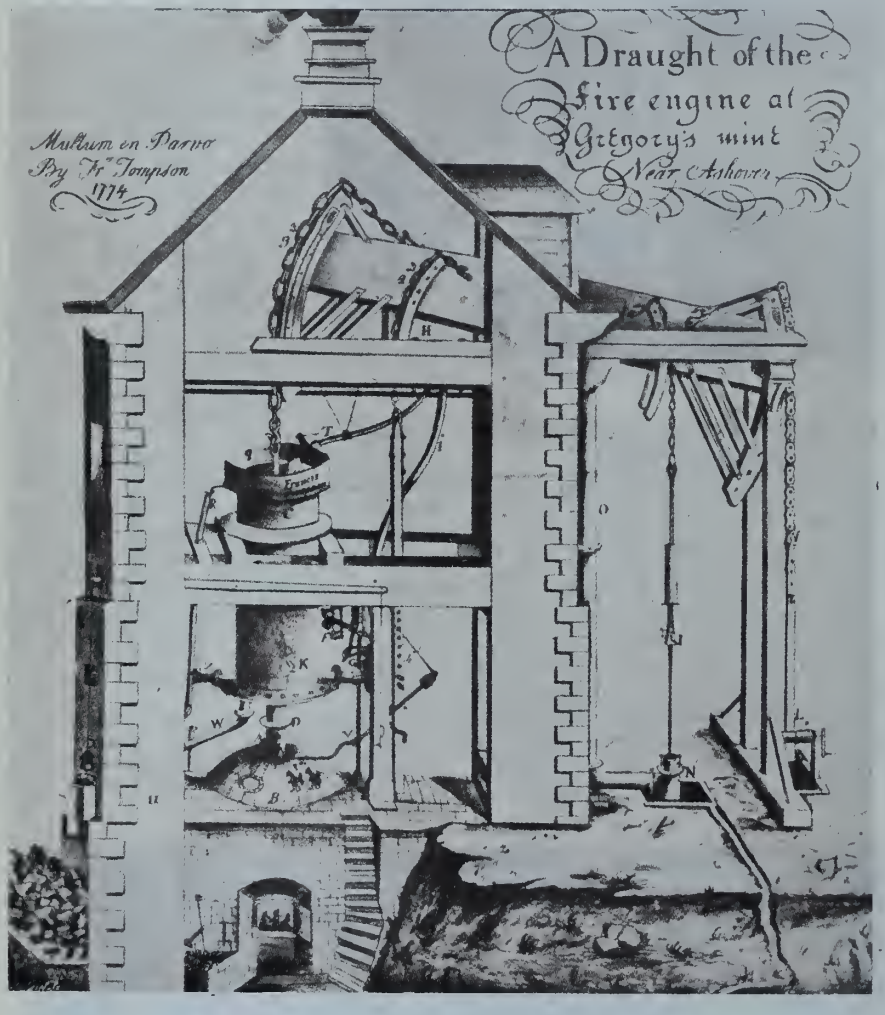
OPERATING SWITCHBOARD—POWER PANELS ON LEFT AND LIGHTING PANELS ON RIGHT.

Describe this engine, B is a large boiler whose water is Converted into Steam, C is the Cylindor, D a Pipe that Joines C the Cylindor and B the Boiler togeather, on the Lower orifice of which within the Boiler mooves a Broad Plate E by means of the regelator A, which keeps in or lets out the Steam occasionlly the Steam of the Boiler ought Always to be a little stronger then the air that when let into the Cylindor C it may be a little More than a Ballance to the Pressure of the External air that keeps down the Pistorn F, the Pistorn Being By this means at Liberty, the Pump rod will by Its Great weight of about 10 or 12 tuns will descend at the opposit End to fech a Stroak, but, as the Pistorn and Weights at the other end do not Exceed half that weight, the End of the Leaver at the Pump will always Preponderate and Descend when the Pistorn is at Liberty, then by Pulling back the Regelator, Stops all Communication of Steam with the Cylindor, then the Leaver Called the F must be Droped to turn the Injection Cock at G and that will Permit the water Brought from the Cistern H by the Pipe I to Enter the Cylindor at K which jet of Cold water being Driven all over the Cylindor Condenseth the Steam Into water again by Reason of its Coldness, and by this means its Bulk is become 14,000 times Less then it was when Steam itself makes a Vacum Suffisent for the Presure of the atmosphere.

[A Part of the Description]—To act again unballanced and to Raise the other End of the Beam with its pump to Discharge the Water at L and this whole operation of opening and Shutting the Steam Regelator and Injection Cock being performed in Little More than 3 Seconds it will Easily Produce 16 Strokes in a minuet. The Cistern H Is Supplyd with water from a Cistern Near the pit N By means of a rod fastned to an arch of the Beam which Drives the water up the Pumps O to the housewater Cistern H. In the Chamber the q at the top of the Cylindor, is a Cup to hold the water that Lies on the Pistorn, which if it Chance to Be two full will Run Down the pipe R, to the hotwell at S, and this Cup is supply'd with water from a Cistern P. In the Chamber By the Pipe T. u Is a pipe that Comes from the hot well to Supply the Boiler with water which is wasted in Generating Steam. U represents 2 Gages of Differant Lengths to Prevent the Surface of the water from Being to high Which is known thus if the Stopcock of the Shorter pipe being opened Give only Steam and that of the Longer only Water all is right. But if both cocks give Steam then the Surface of the water is to Low, or if Both gives water it is to high, hence the Cock which feeds the Boiler may Be opened to Such a Degree as always to keep the Surface of the water to its Proper hight.

W is the Eduction pipe to Carry of the water injected into the Cylindor to Condence the Steam: it is Carried to To the hot well which in the well had a Valve to Prevent the air presing up into the pipe which might hinder the Discharge of the water. X is the puffet Clack or a Valve to try the strength of the Steam which if it Be two Strong or Emoderatly Stronger then the air may Burst the Boiler; the method of trying this Strength is to Lay a weight on the Valve, and If the Steam Shall raise up more then 15 pound weight to one Inch square which is the weight of air nearly on every Square Inch it is a proof that the Steam is Stronger then the air and tho it is of a variable Strength It is never on 1 1-10 Stronger or weaker than Common air, it haveing been found By Expearience that an Engine will work well with 1 pound weight on every square Inch of the Valve X a proof that the Steam is 1-15 part Stronger then Common air. The Small pipe Z is the Snifting pipe and serves to Let out the air Injected with the water which Precipitated Air is forced into the pipe as the Steam rushes into the Cylinder being a Little Stronger then the air; Thus you see a Chain fixed to an arch of the Beam figer the 2nd, at a proper Distance from the arch 3rd. to which Chain is hung a working Plug 4 ft.. which plug has a Long slit in it and Several pinholes and pins for the Morvement of the Gears which we Call the F and Y By which the said Cocks are opened and shut as the Service requires it is Called the working plug or plug-frame which Being Set a Going according to art This Engine is most harmless and manageable of all others.

Editors Note.—As regards the foregoing description. fault cannot at least be found with the lack of detail, the quaint spelling, etc. notwithstanding.



AN EIGHTEENTH CENTURY PUMPING ENGINE.

The Gentleman in Pew 13.—At the recent annual dinner of the Hotel Association, held in the Waldorf Astoria Hotel, New York City, in addressing the meeting under the heading. "Hotels I Have Known," De Wolf Hopper, who with Mayor Mitchel was among the prominent guests present, related an amusing experience in a small town in Maine. There was a convention in the town, he said, and as the hotel was full, his company of forty had nowhere to stay. Finally, the proprietor prevailed on the clergman to open the church to provide sleeping room for the actors. During the early morning the church bell rang and the whole town was aroused.

The landlord sent the porter to see what was the matter, and the porter, a negro said, "Boss, the gent'man in Pew 13 wants two gin rickies."

High Pressure Steam Stop Valve Design and Construction

By D. McNicoll

In what follows, investigation is made of various designs of steam stop valves, particular attention being given those accessory details which contribute to the general efficiency and operation safety of each individual unit, whether for service ashore or on board ship.

IN designing high-pressure steam stop valves, the essentials to be observed are tightness, reliability, simplicity, and safety. In small sizes not exceeding 4 in. or thereabouts and of single-beat type, these essentials are obtained without much call for special consideration, but as the sizes increase the design demands careful attention. In the succeeding columns an investigation of the various designs is contributed, and prominence given to details which affect what might be termed the general efficiency and safety of the fitting.

Fig. 1 shows a type of single-beat unbalanced stop valve frequently used as a boiler stop. The same design in more or less modified form is used throughout most main steam-pipe systems, being met with as an intermediate shut-off or bulkhead stop valve. The valve shown is of 8 in. diameter, the material of chest being cast-iron, internal parts gunmetal, and the working pressure 200 lbs. per square inch. In many instances chests of this size and for this pressure are made in cast steel, but provided the design is carefully observed the choice of material is optional. For larger sizes or higher pressures cast steel is desirable. Independent of pressure, wherever superheat is present, cast steel is essential, and the internal fittings in this instance should be of a high-tension bronze, perferably a nickel alloy.

The features in the design which call for special attention are stresses in the chest due to pressure; stresses due to hardening down; stresses due to expansion of spindle with valve shut; tendency of valve to rotate when steam is flowing through; liability to fracture of seat studs. In settling the thickness of body metal, the general method is to ensure that the aggregate section is such as to allow of a safe stress per square inch of section, but on investigation it is readily admitted that all parts are not equally stressed.

In Fig. 1, assuming that the pressure is present throughout the chest and acting at right angles to the plane of section shown, the stress on the part lettered A is much higher than on the other portions. By way of illustration:—The pressure on the upper half of the outlet and half the cover is approximately 8,950 lbs.; which stresses the section on the top left-hand side to 1,061 lbs., per square inch, whereas the average stress for the aggregate section is only 891 lbs. The cover, of course, takes a portion of the stress due to frictional resistance, and the tighter the cover nuts are screwed up, the greater the assistance given to the weaker section. In a sense this is "robbing Peter to pay Paul," as it simply puts up the stress on the studs.

The stresses resulting from excessive hardening down are in many instances exceptionally high, as is often proved by the burst condition of valve lids. This hardening down is due to an attempt to overcome leakage. It appears providential that the valve lid gives way in nearly every case, or otherwise there might be far more fatal accidents in this connection. Steel crossheads and turned pillars should always be fitted in preference to cast bridges, the latter being anything but safe, particularly in the larger sizes. There is no doubt that in valves over 4 in. diameter a great benefit accrues from the adoption of a flexible seating in conjunction with the solid face. This was introduced by R. R. Bevis, J. H. Gibson and Cockburns, Ltd. With this arrangement leakage from distortion is obviated, and, in addition, there are two faces, so that if one is leaking from any cause of distortion there is always the other one to fall back upon.

FIG. 1.

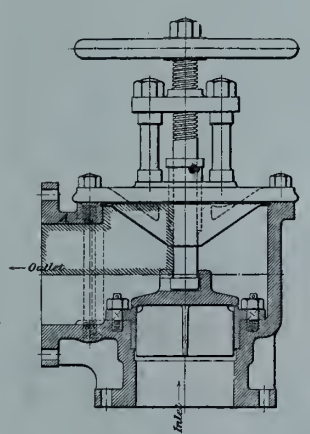


FIG. 2.

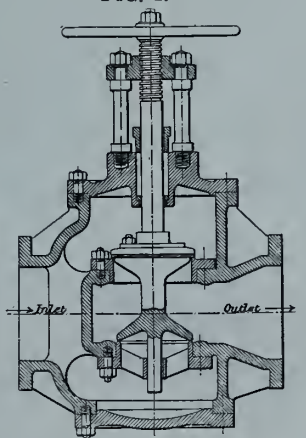


FIG. 3.

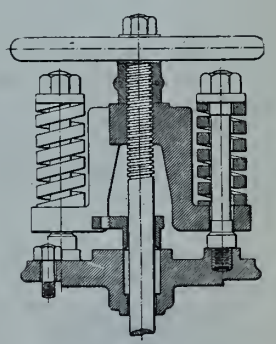


FIG. 4.

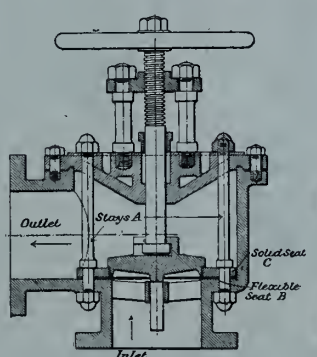


FIG. 5.

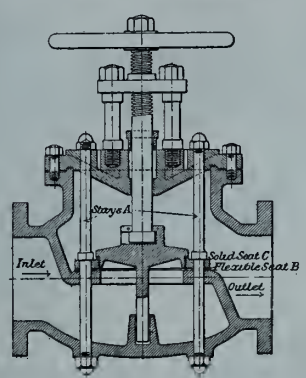
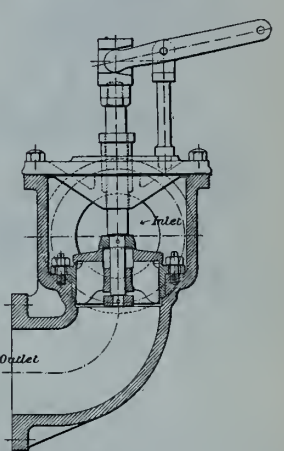


FIG. 6.



Shutting Down Hard When Cold

Another source of high stress is when the valve has been shut down hard when cold, and afterwards steam from other boilers admitted to the top of the body. Even with steam in the inlet side only a fair degree of heat is transmitted to the spindle. In each case the subsequent tendency to expansion puts a stress on all the parts. An actual experience of the author is illustrated in Fig. 2. This was a double-beat type of valve and the bottom seat was attached as shown. The valve was hardened down for a steam test, with the result that after the test a number of the manganese bronze studs from the bottom seat were found lying broken in the bottom of the chest, and all showed signs of fracture, the expansion of the spindle having caused this.

Apart from this, the design of seat is not to be recommended even if the studs do not give way, as the tendency thereby is to cause a leaky joint between chest and seat. Seats should be arranged where valves have to be hardened down so that this hardening tends to make the joint tighter, that is to say the gunmetal seat should be upon the top of the steel seat, and not below it as shown. One method of counteracting the damage from expansion is by fitting a spring crosshead. This is shown in Fig. 3, and is loaded generally from 1¼

*From a paper read before the Institute of Marine Engineers.

to 1½ times the boiler pressure per square inch of valve area, and a higher load than this cannot be put upon the valve spindle, no matter what purchase is used. In Fig. 1 stays are sometimes fitted as shown dotted. These only serve to stiffen the cover and, as will be noticed, still further reduce the section of metal at an already weak section.

The rotation of winged valves when steam is flowing is due either to a slight angle on the wings or to eddies in the steam. The valve can be prevented from rotating but to do this a pin must be fitted or other means adopted. The damage done to valves from this rotation is hardly credible, and calls for the adoption generally of pintle or centre-guided valves.

Valve Seat Fixing

The source of much trouble is the fracture of seat-securing pins or studs. In the large sizes it is quite inadmissible to drive the seats in and secure them by means of a pin or pins through the side of the chest and it is absolutely prohibited in all sizes when superheated steam is present, experience showing in this case that seats driven and secured by side pins become quite slack and allow leakage to occur. The seats in larger sizes are therefore secured in the manner shown in Fig. 1. The only way to avoid serious trouble with this design is to run a wire through the heads of all pins or through split pin holes, if studs are fitted. This prevents the fractured portions being carried to some part where serious damage may be caused.

The question of draining generally cannot receive too much attention, and means should always be provided for efficiently getting rid of all water in both inlet and outlet before a valve is opened.

In Fig. 4 a type of valve is shown which it is suggested is an improvement on that shown in Fig. 1. The first feature that attention is desired to be drawn to is the method employed so that the cover may take up a share of the bursting pressure which acts at right angles to the axis of the spindle. This consists of a tapered spigot on the chest with a corresponding tapered recess in the cover, making a metal to metal joint. The stresses from hardening down and expansion are mainly taken up by the four stays A, which also serve to secure the seatings. With this arrangement no loose parts are situated inside the chest, with the consequent prevention of damage from this source. The valve is centrally guided thus preventing rotation. A flexible seating is shown at B and when this and the corresponding valve face engage, the solid seat C and its corresponding valve face are 1-100 in. open, so that when this latter seat and face engage the flexible seating is deflected 1-100 in. Fig. 5 shows the same design of valve as in Fig. 4, but of straight through or globe type; the design calls for the same attention as in the previous case.

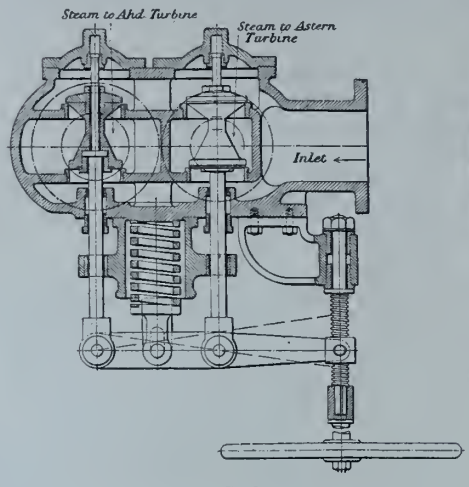


FIG. 8.

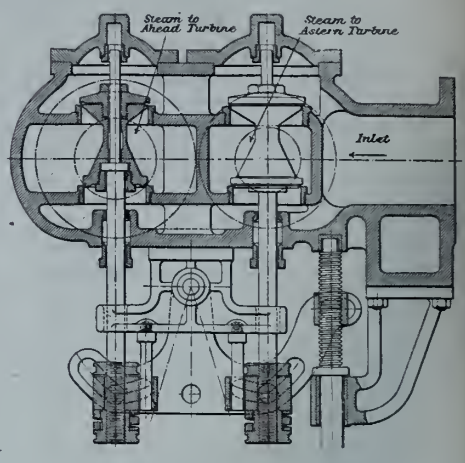


FIG. 9.

fitted or handwheel spanners used to give the same effect or gearing introduced. The difficulty is due to frictional resistance in the screw and not to the direct load which, but for that resistance, would allow for quite a reasonably sized handwheel and comparatively quick-pitched thread in valves up to about 12 in. diameter. For regulating purposes large diameter handwheels or gearing are objectionable, not enabling the valve to be handled as expeditiously as is desirable. A compromise for this type of valve is effected and is shown in Fig. 6. A pilot valve is introduced and lifts first, balancing to a certain point the pressure in inlet and outlet branches. The main valve is then lifted against much less load. This fitting is extensively adopted, but occasionally trouble is experienced from the main valve pulsating or clattering, in reciprocating machinery, due to the fluctuating flow of steam—which causes damage to the internal parts.

Solid double-beat valves got over this trouble in the majority of cases and were perfectly balanced to all practical purposes, but they had one outstanding defect—they were rarely, if ever, steam-tight, which was very unsatisfactory. For reciprocating work this did not affect the steam consumption to any extent, as it was only when the machinery was at a standstill that leakage was occurring, and if a stoppage was of any length of time the boiler stop valves could be shut down. For turbine machinery, however, leaky astern valves can very seriously affect the economy. The leakage in the solid double-beat stop valve was due to differences of expansion between the double-beat valve and the seatings in the chest and could not be got over. A solution of the difficulty was ultimately found in introducing a flexible disc to one of the beats, and the names associated with this introduction were also Messrs. Bevis, Gibson, and Cockburns, Limited. This valve has been very extensively adopted in varying designs and is exclusively used for all regulating valves in His Majesty's Navy.

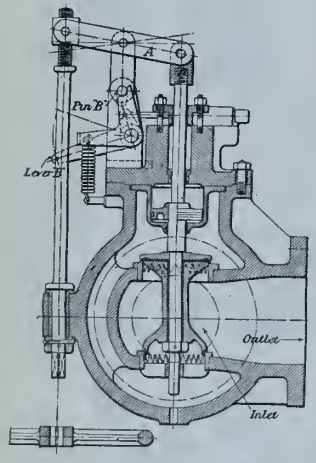
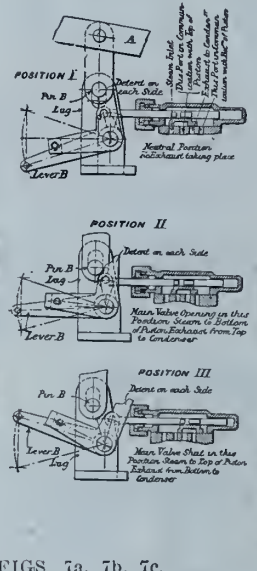


FIG. 7.



FIGS. 7a, 7b, 7c.

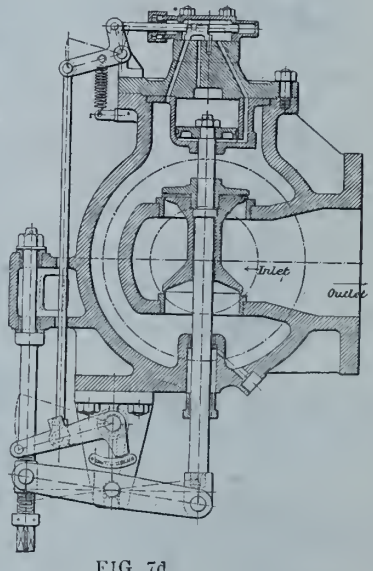


FIG. 7d.

Balanced Valves

In singlebeat valves of sizes over 4 in. and pressures in the region of 180 lb. and above, the valves are difficult to operate unless large diameter handwheels are

Double Beat Valve for Reciprocating Work

Fig. 7 shows a double-beat type of valve used for reciprocating work for regulating purposes and also as a throttle valve, doing away with the butterfly type. In this latter capacity a very light duty is thrown on any form of governing gear, while in larger sizes it obviates the necessity for employing a separate throttle engine, say of the Brown type. For ordinary opening and closing as a regulating valve the pin B is locked by the detents as shown, thus allowing the valve to be positively opened or closed. During these operations the control valve is in the neutral position, preventing steam from passing to the condenser. The operating piston has also inlet pressure on both sides of it, thus effecting a balance. The two beats of the valve have saw-formation spigots; this is to allow of close regulation, particularly where shafting is employed to bring the handwheel to a position not directly below the valve. The back-lash in this instance often allows a big jump to occur in the regulation, which is prevented with the design as shown. This jump is due to the following cause:—

With a valve of this design, that is, with steam entering outside the beats and the spindle going through the cover, there is in the first instance a closing effort due to the pressure on the increase in area of the top beat. The pressure on the area of the spindle where it passes through the stuffing-box is an opening effort. Generally the ratio of the former area to the latter is as two to one, with the result that when the valve is opened to an extent allowing half the initial pressure to be present in the outlet the efforts balance each other. A pound or two over this and an opening effort is present, with the result that the valve jumps open whatever play there is in the operating gear. With the saw formation of spigots this jump does not affect the revolutions to any extent. If instead of the spindle coming through the top of the cover it had come through the bottom of the chest the effort would have been a constant closing one, and there would be no necessity for the provision of the saw formation of spigot. Further on, valves with their spindles coming through the bottom of the chest are shown in Fig. 7d, 8, 9 and 10. The saw formation of spigots is a refinement to give close regulation from dead slow to full speed, as many doublebeat valves are made without this formation. When the valve is opened to any degree of regulation it can be shut and opened again by the throttle gear in the following manner: In Fig. 7a, b,c the throttle lever B is moved from position 7a to 7c. The control valve during this operation moves through position 7b, holding the main valve open till the detents have cleared themselves from the pin B, then with the throttle lever in position 7c the main valve closes—the levers swinging from the nut on the regulating screw. To open up again the lever B is returned to position 7a, the main valve opens up and the small tension spring returns the detent, again locking pin B and putting the valve into a position of positive control. This fitting has given general satisfaction and has been extensively adopted.

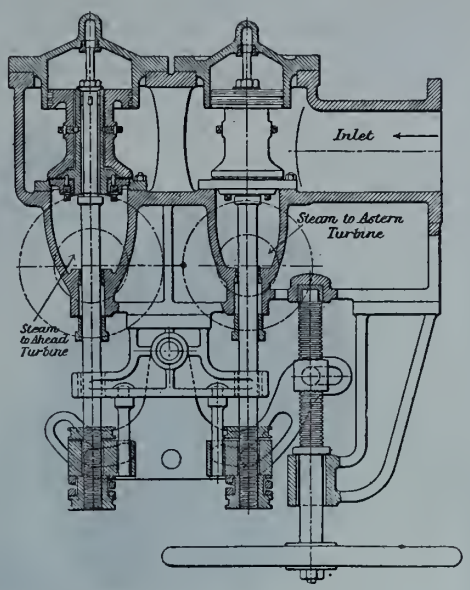


FIG. 10.

In future it is intended to make the last type of valve as modified and shown in Fig. 7d. A constant closing effort is present, which will allow of perfect regulation under all circumstances and will not necessitate the adoption of saw-formation spigots on the beats. The action under throttling conditions is similar to the former valve, with the difference that the slide valve is returned from position 7c to position 7b and 7a by the spring, assisted by the inlet pressure on the area of the slide-valve spindle where it passes through its stuffing-box.

Hardening-down stresses are alleviated by the expansion of the spindle under temperature. The illustration also shows the relative positions of ports and passages, and consequently gives a better idea of the connection between the positions of the controlling slide valve and the positions of the main valve than is shown in Fig.7.

To prevent water coming down between the spindle and stuffing-box of the main valve, as far as possible, the stuffing-box is kept high in the inside of the chest, and a drain-hole provided at the top of the packing to drain any water that may tend to accumulate there to the bottom of the chest. Provision is also made for taking away any drips that may come down.

In both the foregoing valves the design has been devised from the point of view that the relative positions of the indexes for both main and throttle valves at the starting platform are exactly similar to those where separate valves are fitted. A point of particular importance has also been carefully observed in the design, namely, that wear and tear have no effect on the efficiency of the gear.

Regulating Valve for Turbines

Fig. 8, page 58, shows a type of ahead and astern doublebeat regulating valve for turbine machinery, of which a large number have been fitted. With this arrangement one handwheel only is necessary. In a mid position both valves are shut, rotation in one or other direction opens either valve, the shut valve meanwhile becoming the medium of the fulcrum for the opening valve. In a design of this sort it is essential that the handwheel should be most clearly marked by arrows for rotation for ahead and astern. Not only should the handwheel be marked, but an index should be fitted with a pointer of considerable travel indicating quickly which valve is being operated and in what direction. This also applies to single regulating valves because, while in the majority of cases valves are shut by what is termed a clockwise motion, that is right-hand when looking on the handwheel, with the valve or extending spindle receding from the same, there are cases of extended spindles where the motion is clockwise looking in the opposite direction.

With the arrangement as shown in in Fig. 8 it is possible, if the spindle of the open valve seizes in the neck bush or gland and it is desired to shut this valve and open the other one, that instead of shutting the open valve first the other valve is opened up—a most undesirable effect. To obviate this the design as shown in Fig. 9, has been adopted, with most satisfactory results. Here the open valve must be positively shut to the point of the spigots entering the seats before the opposite valve can be opened. After this point the valve is closed and contact made with its seat by the pressure of steam on the difference of area of the two beats of the valve, plus the pressure into the area

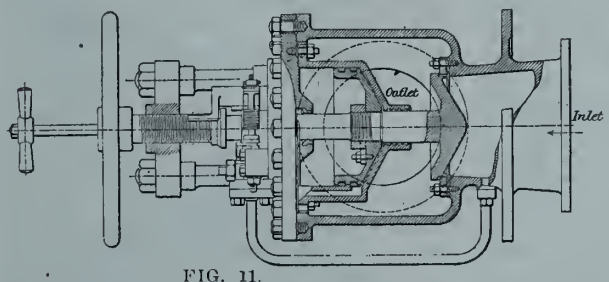


FIG. 11.

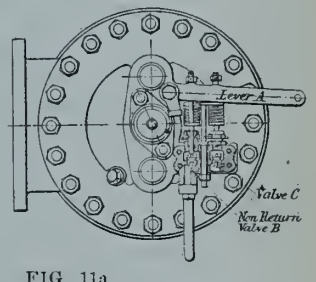


FIG. 11a.

of the valve spindle where it passes through the stuffing-box. The springs on the spindles also assist this effort. No greater closing effort can be put upon the valve. In this respect it differs from the fitting shown in Fig. 7, where, of course, the valve can be hardened on its seat to any extent.

Another arrangement of balanced valves which has a much greater final closing effort, and consequently ensures tighter valves, is shown in Fig. 10. The valves are balanced by the control valve, which forms part of the spindle, first exhausting steam from the top of the piston. Another outstanding feature is the simplicity of the chest casting, particularly desirable in cast steel. The closing effort when the valves are shut is the pressure on the area of the valves. In these designs of double manoeuvring valves and valve as shown in Fig. 7b it will be noticed there are no stresses due to expansion of spindles.

Valve for Turbine Service

A valve widely adopted in conjunction with turbine machinery for both naval and mercantile work is shown in Figs. 11 and 11a. This fitting is a combined bulkhead shut-off and emergency valve. It also fulfills the function of a self-closing valve in naval work. For ordinary opening and closing the valve is operated in the usual way by means of a handwheel. In the larger sizes it is necessary to employ a handwheel spanner. When the main valve commences to open the collar on it has an inclined plane action on the lever A which lifts the spindle of the non-return valve B, allowing steam to pass to the top of the piston and check any sudden opening tendency. The leakage past the piston rings determines the opening speed of the valve. For shutting by throttle or emergency gear, the lever A is moved further, which opens valve C; this exhausts steam from the under side of the piston, when the pressure on top of it closes the main valve. On returning the lever the main valve slowly opens up to its previous amount of lift. For naval work, where there are two or more bulkhead valves, if the pipe on the inlet side of one valve is shot away the valve is supposed to self-close with the reverse flow of steam. When this occurs the non-return valve B also closes. The efficiency of this fitting was lately demonstrated unintentionally in a fast ship of war. An exceptionally heavy sea broke over the vessel, the turbines stopped, and for some time no explanation was forthcoming; ultimately it was found that the sea had carried some gear against the deck emergency lever and moved it into the shut position, with the result that both bulkhead emergency valves were effectively shut.

Fraser S. Keith, B.Sc., for the past eighteen months editor of *Construction* has been appointed secretary of the Canadian Society of Civil Engineers, Montreal, in succession to Professor C. H. McLeod, resigned.

BLOWOFF TANKS FOR STEAM BOILERS

THE blowoff pipes of steam boilers usually discharge directly into the air, into drains, sewers, or pits; but it is not always practicable to solve the blowoff problem in this simple way. The clouds of steam that rise from the pipe may constitute a nuisance; the noise may be objectionable, or the force with which the water escapes from the pipe may be sufficient to cause prohibitive damage of some kind. In cities, for example, boiler owners are often forbidden, by ordinance, to blow their boilers off directly into the sewers, and yet there may be no place where a blowoff pipe could be discharged directly into the atmosphere without danger of scalding somebody, or without infringing upon the just rights of one's neighbors. In a case of this kind a special blowoff tank must be provided to receive the discharge, and to hold it until it can be disposed of in some approved way.

FIG. 1. AN EXPLODED BLOW-OFF TANK, PERFORATED BY CORROSION AT "A."

Blowoff Tank Explosion

The man who must use a blowoff tank usually believes that anything that will hold water is good enough for his purpose, and hence it happens that the lowly but necessary blowoff tank seldom receives the attention that it deserves. We wish to call attention, says the *Travelers' Standard*, to the importance of giving more thought to this adjunct of the boiler room, and to make our remarks more tangible and real, it will be convenient to take as a text the accident that occurred on October 27, at the pumping station of the Toledo, Ohio, waterworks, by which one man was killed in consequence of the explosion of a tank of this kind. We might equally well have taken any other accident of like nature—and it would not be hard to find another, because they occur every little while.

The exploded vessel, in this case, was made of cast iron, and it was not originally intended for use as a blowoff tank, though it is said to have been in service for this purpose for about twenty years. It was 30 inches in diameter, and before it was destroyed it was approximately 10 feet long. A part of it is illustrated in Fig. 1, and a glance at the engraving will plainly show that the metal had wasted away a good deal, from oxidation. In fact, the shell, which was originally ⅜ of an inch thick, had been reduced in this way until it was less than a quarter of an inch thick in a number of places, and at one point (shown at A in Fig. 1), the corrosion had extended entirely through the shell, so that a small opening had been formed.

The tank stood below the floor level, in a vertical position; it had, on top, two 2½-inch pipe connections for receiving the blowoffs from the boilers—its contents being eventually passed into the sewer through a six-inch pipe-connection in the side, which can be seen in the upper part of the engraving. The nozzles that appear in the photograph had been blanked off. They were, in a sense, "relics of a previous existence," for they had served no useful purpose since the vessel was first put to use as a blowoff tank.

The explosion broke the tank in two, the part shown being blown upward into the air, while the remaining portion was not moved from its original position. The photograph shows an iron reinforcing bank encircling the tank, and there were two other similar bands on the part that remained underground after the explosion. The fireman, William Grassman, stepped upon the top of the tank an instant before it gave way. He was thrown into the air, and fell to the floor directly in front of the broken blowoff connection, through which one of the boilers was being blown down. He was badly scalded by the escaping steam and water, and died from the injuries he received.

An examination made after the explosion occurred revealed an old crack extending circumferentially around the

tank for a distance of about 24 inches. It was this weakness or defect, combined with the general corrosion of the shell, which led to the explosion. When the failure occurred, the shell fractured around the entire circumstance, the line of rupture following the earlier crack.

We have no definite information concerning the conditions that made it possible for a sufficient pressure to be generated in the tank to produce this explosion, but we do know that similar accidents occur every little while. The failure here under consideration may have been caused by water-hammer action, or the discharge pipe may have become stopped up so that the tank was subjected to full boiler pressure—there being no free vent to the atmosphere. These are only surmises, however.

The Explosion and Its Lessons

Several lessons may be learned from this explosion. The first and most important one is, that every blowoff tank should be regularly examined, internally and externally, by a competent inspector. For this purpose a manhole is required (the exploded tank had none), and if the tank is set below a floor or below the ground level, sufficient space should be left on all sides to permit thorough inspections of the entire surface.

Secondly, every blowoff tank should have, as a safety feature, a vent of ample size, opening freely to the atmosphere. Under ordinary conditions the vent pipe conveys nothing but steam, but it might be of great value in relieving the pressure on the tank in case the discharge pipe should become stopped up.

The third lesson is, that blowoff tanks should be well designed and constructed. Under normal conditions a blowoff tank, if properly installed and operated, would not be subjected to a pressure exceeding (say) 25 pounds per square inch, but something occasionally happens, as in the present case, to interfere with the normal conditions, and the pressure may then be so greatly increased that the tank will give way unless it has been constructed with a contingency of this kind in mind, and provided with an ample factor of safety. Possibilities of this kind have been seriously considered by engineers, and, as a result, the laws of some States require that blowoff tanks shall be strong enough to safely withstand the full pressure carried by the boilers with which they are connected. The additional expense to which the owner may be put, in order to make a tank amply strong, is not very great, and the security that is obtained in this way is well worth what it costs.

Attention should be called to the danger of suddenly opening a blowoff valve and discharging the contents of a boiler into a blowoff tank that is already nearly full of water. Such a procedure inevitably produces a considerable pressure in the tank, particularly during the time that is required to establish a free flow of water through the outlet pipe. In fact, it is reasonable to suppose that for a short period, at least, the tank might be subjected to a pressure approaching that in the boiler which is being blown down. It should be remembered, too, that pressure applied to a structure suddenly will exert a potential bursting effect considerably greater than that produced by the same pressure when applied gradually.

Vent Pipe Essential

Every blowoff tank should have a vent pipe which should be kept constantly in free communication with the atmosphere. Valves should never be placed in vent pipes, and every possible precaution should be taken to prevent them from becoming stopped up in any way. Moreover, it is important to note that a vent pipe may give rise to a static pressure in the tank, in case the outlet by which the water normally escapes from the tank becomes stopped up. If such a stoppage occurs, the water that is blown out of the boiler can escape from the tank only through the vent pipe, and if this pipe runs up to the roof of a building of considerable height, and is filled with water, the tank will be subjected to the static pressure that is due to this column of water. For example, if the building were 80 feet high, and if the vent pipe were of the same length and full of water, the blowoff tank would be subjected to a static pressure of approximately 35 pounds. The complete stoppage of an outlet pipe from a blowoff tank would be unusual, but it might occur accidentally or through gross neglect, and we know that accidents have been caused in this way.

Mud and scale, and possibly other substances also, are likely to collect in the bottom of a blowoff tank, in quantities depending largely upon the character of the boiler feed water. It is important to remove such accumulations frequently, to prevent the destructive corrosion of the lower parts of the tank, and to avoid any chance of the plugging of the escape pipe. A manhole should always be provided to permit such cleaning, and handholes are also convenient, in addition.

Horizontal Blowoff Tank Design

We present, herewith, a sketch showing an approved design for a horizontal blowoff tank. The sizes of the vent, inlet, and discharge pipes have been purposely omitted, because they will vary according to the size of the tank, the number of boilers that discharge into it, and other similar conditions. The area of the outlet pipe should always be greater than the combined area of the blowoffs from the several boilers, so that the water may escape from the tank freely and rapidly, and without the production of an excessive back pressure, even if all the boilers are blown down simultaneously. It is highly important, also, to run the outlet pipe full size for the entire distance from the tank to the sewer. The inlet pipe should always enter the tank at a somewhat higher level than the highest part of the discharge pipe. Otherwise, water might back up into the inlet pipe, if the tank should become filled, and a water-hammer action might result upon opening a blowoff valve.

Blowoff tanks should never be made of cast iron. The best quality of boiler steel should be used, and the thickness of the shell plates and heads, and the type of riveted joint, should be such as will give a factor of safety equal to that of the boilers themselves. It is advisable, moreover, to make the shell and heads somewhat thicker than is necessary to withstand the pressure to which the tanks may be subjected, because these tanks are usually situated in damp places, and are therefore likely to be affected by corrosion. The extra thickness of metal will insure for the tanks a longer useful life. It is wise, too, to give a blowoff tank a good coating of protective paint, both internally and externally, and to renew this coating from time to time, when the boilers are out of service, so that the tank can be thoroughly dried out.

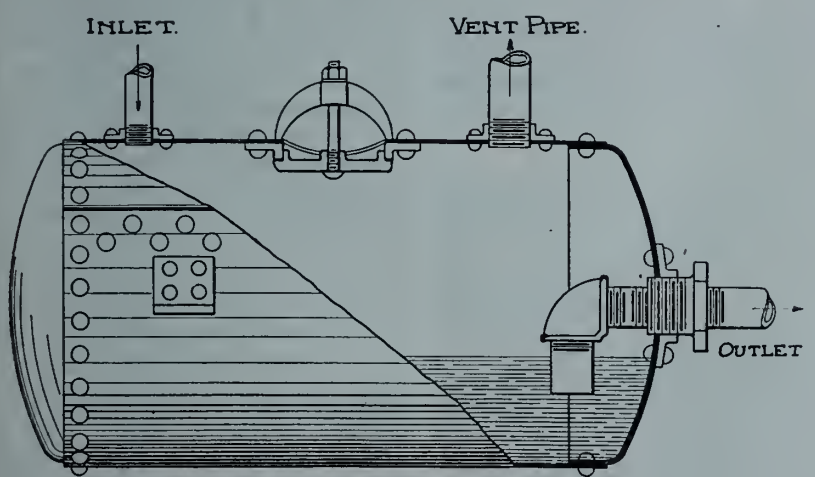


FIG. 2. APPROVED DESIGN FOR A BLOW-OFF TANK.

Richard Bell, for the last twenty-three years chief engineer of the pumping station at Sarnia, Ont., died on February 19th, aged 43.

G. Gordon Gale, formerly general manager and chief engineer, Hull Electric Co., has been appointed vice-president and general manager.

Steam and Its Generation

STEAM POWER ECONOMICS*

By C. E. Stromeyer.

THE present war, with its accompanying high prices and the possibility of a trade war after the conclusion of peace, has naturally directed attention to many economic questions, including those relating to steam boilers.

Discussions about the difference between English and German economic systems of operating factories have revealed that abroad great harmony exists between the State and manufacturers, and, as a consequence, German works have adopted systems which commend themselves because of their leading to national economy. Our customs seem to force individual works to think more of themselves than of the country's welfare. Here we need only concern ourselves with the fuel question which is briefly as follows: Our manufacturers have been spoilt by the ease with which they could obtain the very best coal in the world. When new labor-saving appliances were invented which, while increasing the output, also increased the power required to drive them, the manufacturers filled their works with them and overworked their boilers; and as this could only be done with the best of coal, slack was for long periods a drug in the market.

Wasted Coal Percentage

Constant improvements in mechanical stokers have effected a change, but no overworked boiler can burn dirty coal, no matter whether it be fed by hand or by mechanical means, and slowly but surely colliery owners found that it did not pay to bring inferior qualities of coal to the surface. As most coal seams consist of several layers, of which some are rich and others poor, the poorer layers of worked seams are often left underground and buried for ever, because to mix them with the richer ones would disproportionately lower their value.

According to recent statements by coal experts, this wasted coal amounts to 25 per cent. of the output. This national waste is due largely to our almost universal practice of overworking boilers. Bunker coal for steamers must, of course, be as free as possible from mineral matter, and export coal has also to be reasonably pure, but there is no reason, except want of boiler power in our factories, why inferior coal should not be burnt wherever it can be got. It is done on the Continent of Europe, because first-class coal cannot be obtained, but there the works provide themselves with ample boiler power, and on the whole they obtain a higher efficiency than we can hope for with our superior coal but hard-worked boilers.

Coke as Fuel

Somewhat similar remarks might be made about the burning of coke. It is a by-product of the gas works of towns, and might with gas be a valuable by-product of works which would make it their business to produce sulphate of ammonia and the volatile oils of distillation. Coke ought, therefore, to be a cheap fuel. At present, however, its production is limited, and those consumers who are compelled to use it as a fuel can be made to pay so heavy a price for it, that the profits can be used for relieving the rates. Steam users naturally do not like coke, partly on account of its relatively high price and partly because it would require larger boilers than the present ones in which to burn it with as good effect as the best coal. Thus, here again, our habit of getting the highest possible duty out of our boilers may be looked upon as being one of the causes, though perhaps only a secondary one, which hamper our coal-tar industry.

Our present practice may possibly be more profitable to the individual factories and collieries than to those of the Continent of Europe, though this is a moot point, but there can be no doubt that this practice is very wasteful of our national coal resources, and it is to be hoped that after the war encouragement will be held out to those who, without loss to themselves, will assist at national economy.

Take the simple case of a shipowner who has to decide for what speed a ship, which he contemplates ordering, should be designed. He knows that with a low speed his ship cannot command paying freights, and, going to the other extreme, he also knows that if he fills his ship with engines and boilers, there will be no room for cargo, and his coal bill will be far in excess of his earnings. He will, therefore, have to decide on a medium speed which here may be assumed to be 10 or 11 knots. With the faster ship he will be able to make 10 per cent. more voyages than with the slower one, but his annual coal bill will be increased 20 per cent. and his carrying capacity slightly decreased, on account of the extra 20 per cent. of engine, boiler, and bunker capacity. Leaning on past experiences he may be able to say to himself that his prospective earnings would be about the same, no matter whether he were to decide on the 10 or the 11-knot boat. At this point national economic considerations ought to influence him, and he ought to say to himself: The 11-knot boat will carry 10 per cent. more cargo than the 10-knot boat, but it will burn 20 per cent. more coal. My profit will be the same with either speed; therefore, in order to assist my country in saving coal, I will decide to have the slower boat.

The factory owner is faced with other, but similar, problems, and will find that he too can make selections amongst a number of alternatives of which he should choose the one which, while it does not affect his profits, will be of economic advantage to the nation. It will be my endeavor to review these several alternatives.

Fuel Cost Contributories

The cost of fuel depends, of course, on the cost of labor, and that depends on the average cost of living. This will necessarily be increased after the war on account of the heavy taxation to which we as a nation will be subjected; but it is impossible to make even the vaguest guess as to the extent to which future prices of fuel will be affected by the increase in cost of fuel which may occur. We may assume that the coal consumption for a first-class modern steam engine can be reduced nearly down to one pound of coal per indicated horse power, or nearly 4 tons per year continuous working. In most factories only about one-third of the full time is worked, whereas the interest on capital is a continuous charge, and the total cost, including wear and tear, was in one modern factory found to be $60 per indicated horse power per annum, at a time when the cost of fuel was $3 per ton. Had the factory been working night and day the cost would have been $30 per indicated horse power per annum.

This compares very unfavorably with $8.50 to $12.15 per electric horse power, which is approximately the cost of continuous power production in some parts of Sweden, Norway, and on the slopes of the Alps. These districts are rapidly realizing that they can control enormous powers, and when these have been harnessed they are sure to attract to themselves many of our industries. After the war, wages now ruling are likely to be at least maintained, and the disproportion is likely to be increased. Then

*From annual report of Manchester Steam Users Association; of which Mr. Stromeyer is Chief Engineer.

also, as the United States is not going to burden herself with additional taxes, the cost of living will not be increased there. The most threatening possibility, however, is that Prussia, true to her national traditions, not to be saddled with a national debt (her present one of 600 millions being merely an industrial one created when the State acquired all the railways), may repudiate all her internal war loans, and after a few years of severe personal hardship the taxation in Prussia, and consequently the average cost of living, and with it the price of labor and of coal, will be as low as before the war.

Record of Engine Performances

We may, therefore, expect that some time after the war, our cost of creating power for industrial purposes will be greater than in other countries, so that even without considering the question of economizing our national coal resources, it will be necessary for individual works to practise extreme economy as regards coal consumption.

In order to be able to reach a reliable starting point as to possible fuel economies, I have prepared the following list of engine performances. This is merely a repetition of the work which was done quarterly during the infancy of the Manchester Steam Users' Association, for at that time it was the custom to collect and publish information about the engine performances of our members. There seems to have been a greater willingness in those days than now to let us have the desired details, for although our membership has enormously increased since then, the present list is much smaller and less comprehensive than our earlier ones.

The majority of the recorded results are from spinning mills, and these have been classified according to the type of engines used, viz., low and high pressure compound, compound using superheated steam, and to triple expansion engines. The original returns embody the amounts of coal used for non-power purposes. In those mills where a separate boiler, usually a low-pressure one, was used for burning this coal, the return may have been fairly correct, but other returns are mere guesswork. However, by combining the most reliable of the available cases, the average fuel consumed in spinning mills for non-power purposes was found to be about 0.6-lb. per indicated horse power. In ring spinning mills the quantity is probably only 0.5-lb., partly because much of this power is converted into heat, which helps to warm the rooms.

Spinning Mill Power

The deductions which can be drawn from that part of the table which deals with the cotton spinning mills are, roughly speaking, that compound engines using steam of 100 lbs. pressure consume about 3.0 lbs. of coal per indicated horse power. For high-pressure compound engines, the net consumption is about 2.15 lbs. of coal per indicated horse power, and for triple-expansion high-pressure engines it is about 1.65 lbs. of coal per indicated horse power. The few compound engines which use superheated steam do not show up as well as might have been expected, but with one exception these engines are of an old type.

These results are neither as good as the results promised by engine builders nor as those attained during trials. This

Works No.	Date.	Steam Pressures. Lbs	Mean Indicated Horse-power.	Mean Coal Consumption per I.H.P. Gross. Lbs	Heating, etc. Lbs.	Nett. Lbs.	Remarks.
Cotton Spinning Mills. Compound Engines.							
1	—	85	770	2 90	0 87	2·03	
2	—	85	500, 520 380, 300	3·56	—	—	Up to 1913.
2	—	85	do.	3·23	—	—	After 1908, but later consumption increased to 4·091bs.
3	—	100	50 single 270, 260	3·58	—	—	Up to 1904..
3	—	100	50 single 290, 270	3·67	—	—	After 1904.
3	—	100	50 single 280, 270	3·76	0·89	2·87	One trial 1909.
4	—	100	620	3·13	0·32	2·81	Up to 1914.
4	—	100	390	4·57	0·76	3·81	Reduced power after 1914.
5	1864	100	400, 400	4·09	—	—	Burning slack.
6	1879	100	590, 230	2·71	0·89	1·82	
7	—	100	350, 350 450	3·85	0·71	3·14	
8	1885	105	1000	2·34	0·28	2·06	
9	—	107	450	3·80	0·60	3·20	Only two years' tests
10	1900	120	640	2·60	0·13	2·47	Only one test.
11	1833	130	1200	2·72	—	—	
12	1909	138	700	2·81	—	—	Only two years' tests
13	1910 1899	145 145	690 980, 550	2·85	0·66	2·19	690 is a triple expansion engine.
13	1899	145	1100, 280	2·67	0·60	2·07	
14	1877 1875	160	380 980	2·69	0·40	2·29	
15	1910	160	700	2·78	0·62	2·16	Only one test.
16	—	160	1400	2·32	—	—	Friction of engine, main and countershafting 24·6 %
17	1910	180	1200	2·65	0·34	2·31	
18	1913	180	1220	2·18	0·32	1·86	Only two years' tests
Cotton Spinning Mills. Compound Engines. Superheated Steam.							
19	—	85	400, 400	3·14	1·10	2·04	Only two years' tests
20	1885	100	100 single 1300	2·56	0·83	1·73	Only two years' tests
21	1873	140	580	2·71	0·67	2·04	
22	1910	160	1300	2·20	0·45	1·75	

TABLE I. DATA FROM MISCELLANEOUS INDUSTRIAL PLANTS OF 300 I.H.P. AND OVER.

Works No.	Date.	Steam Pressures. Lbs.	Mean Indicated Horse-power.	Mean Coal Consumption per I.H.P. Gross. Lbs.	Heating, etc. Lbs.	Nett. Lbs.	Remarks.
Cotton Spinning Mills. Triple Expansion Engines.							
23	1907	168	1480	2·02	0·38	1·64	Only one test.
24	1905	180	1400	2·33	—	—	
Weaving Mills. Compound Engines.							
25	—	80	320, 320	2·97	0·61	2·37	Up to 1903.
25	—	80	350, 340	2·77	0·60	2·17	Engine speeded up in 1903.
26	—	85	330	3·46	0·25	3·21	Up to 1908.
26	—	85	340	3·53	—	—	After 1908.
26	—	85	260	4·18	—	—	Do. Low power.
27	—	105	500, 280	3·43	—	—	
27	1915	160	560, 290	3·20	—	—	A new engine, one test
28	1898	120	340	3·96	1·81	2·15	
29	—	120	400	3·23	1·07	2·16	
29	—	120	346	3·80	1·37	2·53	Reduced power.
30	1909	160	450	2·30	—	—	Only two years' tests.
31	1907	165	1200, 900	2·33	0·31	2·02	Only one test.
Worsted Spinning. Compound Engines.							
32	—	90	510	4·58	0·42	4·16	Up to 1912. Overworked 1912. Reduced h.p. cylinders and added an auxiliary engine.
32	—	90	400, 160	3·92	0·34	3·58	
Silk Works. Compound Engines.							
33	—	73	280	4·25	1·45	2·80	
Paper Works. Compound Engines.							
34	—	133	750	4·25	—	—	Only one test.
Flour Mills. Compound Engines.							
35	—	120	350	2·88	—	—	
36	1880	80	360	2·94	—	—	Only one test.
36	1911	160	350	2·00	—	—	Fuel saving stated to be 20 tons per week of 136 hours.
Wire Works. Compound Engines.							
37	—	120	430, 420	2·24	—	—	Only one test.

TABLE II. DATA FROM MISCELLANEOUS INDUSTRIAL PLANTS OF 300 I.H.P. AND OVER.

is but natural and should not be allowed to influence intending purchasers, for it must be remembered that a factory engine stands idle for two-thirds of its time, and that the raising of steam and the banking up of fires costs much fuel, say, 0.3 lb. per indicated horse power. If we make this further deduction we arrive at the following average net consumptions per indicated horse powers under ordinary working conditions, which are, of course, never as favorable as trial conditions, at which the makers attend and try to minimize all losses.

Old compound engines working with about 100 lbs. pressure consume about 2.70 lbs.

High-pressure compound engines consume about 1.85 lbs.

High-pressure compound engines with superheated steam consume about 1.45 lbs.

Tripe-expansion engines consume about 1.33 lbs.

Several cases in the table show how disadvantageous it is to use engines which are either too small or too large for the power produced by them, and one case demonstrates the advantage of speeding up an engine, but this remedy has its limits. No. 16 was tested with only the main and countershafting running, and showed that only about 75 per cent. of the indicated horse power reaches the spindles.

Weaving Mill Power

The information gathered from weaving mills is very unsatisfactory, for the average returns for heating and slashing, which ought to be very much more than spinning, are only about 0.8-lb. per indicated horse power; or if we deduct 3.0 lbs. net, as found for low-pressure compound engines of spinning mills, from the gross power of similar engines in weaving sheds, the coal used for heating and slashing seems to be only 0.4 lb., which is 0.2 lb. less than for heating alone. This discrepancy may be due in part to the fact that weaving sheds are flat structures and, therefore, not cooled as much by cold winds as are the high-built cotton mills. Possibly, too, the relatively heavy coal bills for power, heating, and slashing, tend towards rigid economy in the engine and boiler departments. On account of these uncertainties the following single case of a spinning and weaving mill may prove of interest, for here the heating was done by separate boilers.

Very careful records have been kept for a full year and the results work out at 1.36 lbs. of coal per indicated horse power, for power alone, and 1.23 lbs. for heating, slashing, and washing; deducting 0.6 lb. for heating, the slashing and washing process in this mill costs 0.63 lb. These works make fancy cloths—these include thick materials, for which the spinning and weaving powers are less than the average cloths, and for which the water to be evaporated in the slashing process is a maximum.

The above works produced their own electricity by means of a turbine. In some parts of the mill each loom has its own motor, in other parts a large motor is attached to the countershafts. Here the losses will be about 8 per cent. for the motor, and 15 per cent. for the countershafts, and then there will be about 10 per cent. loss between the turbine and the switchboard. The efficiency of this part of the works will, therefore, be $90 \times 0.85 \times 0.92 = 66.5$ per cent. The small driven motors on the looms will have an efficiency of about 10 per cent., so that the efficiency will be about $90 \times 0.9 = 81$ per cent. The mean efficiency for the whole mill will, therefore, be about 74 per cent. This is practically the same efficiency as determined for mill No. 16 in the table. Electricity measured at the switchboard is practically the same as brake horse power and, therefore, an electric unit is equal to about 1.5 indicated horse power.

Flour Mill Power

The tabulated results for flour mills are too few for the obtaining of average results, but the saving effected in the case of mill No. 36 is very gratifying. The data are of importance to those whose engines are of an old type, and, therefore, likely to be inefficient, because it will give some indication as to whether advantages are likely to be gained by renewing the installations on midern lines. Of course, each case must be judged on its merits.

Now it is evident from the above table that, as a rule, only about 1 lb. or 2 lbs. of coal per indicated horse power, or, say, $5 to $15 per annum, is likely to be saved by modernizing an old power plant. If, in addition, arrangements were to be made, by providing ample boiler power, for burning a cheaper quality of coal, a very great monetary saving might be effected, but unless collieries will provide inferior fuel to individual works, this desirable policy can only be carried out by large combinations of power producers.

Production and Transmission of Power

The Newcastle Electric Supply Co. has in a way shown what can be done in this direction, and their work has also revealed the difficulties which would have to be overcome in other districts than their own before success can be obtained. Their leading idea seems to have been to provide trunk wires which would do for power what railways do for goods. They provide collieries and ironworks with outlets for any power which may be produced from their waste coal and from the waste heat of their furnaces, and they thus provide the means for the sale of this power which would otherwise be wasted. This company has in some respects been favored by local conditions, but it had also to contend with serious difficulties which are even more serious in other districts. It had the advantage of promises from all the large works on the Tyne to buy power from them, and its first power stations could, therefore, be designed to work with large units and with a minimum of cost. Subsequently the North-Eastern Railway Co. agreed to purchase all its power for local traffic.

On the other hand, the Board of Trade limit on the voltage in the trunk wires made these connecting links very expensive, and as nearly every old power station had its own voltage and its own frequency of phase, practically every amalgamation necessitated the erection of entirely new installations. An initial difficulty, which has however been nearly overcome, was that the numerous corporations had the right to exclude outsiders from supplying their little districts with power; but they have seen the advantage of adapting their voltages and frequencies of phase to those of the company, and now they buy their electric power from it for the purpose of distributing it amongst their customers.

As far as can be ascertained, the charge per unit of electricity, if used all the year round without a break, has been reduced to about $22.50 per electric horse power. For eight-hourly supply, the charge would, of course, be much heavier, possibly as heavy as the cost of individual power production by a modern steam engine.

One reason why power can be produced thus cheaply is that the company with its network of transmitting wires can deal with collieries on the following lines: Each colliery can bring, or brings to bank some very dirty coal or shale, which is absolutely unsaleable. Of this fuel about 25 per cent. can be burnt in the colliery boilers, but the remainder is thrown on waste heaps and is occasionally burnt there. Now, the company, by installing a power station with ample boiler power close to the collieries, could consume all this apparently valueless fuel and produce four times as much power as was needed by the colliery. The colliery buys its quarter share and the rest is carried away in the trunk wires.

Ironworks are utilized in the same way. The heat wasted by the gases which escape from blast and other furnaces is far in excess of the power requirements, and was largely wasted, because without a trunk system to carry away the surplus power it could not be used. Now all this waste power is bought at a cheap rate and distributed.

In other industrial districts the conditions for conveying and selling power are rather unfavorable. The numerous corporations still exclude outside producers from within their boundaries, nor will they buy from outsiders, and they have not the necessary powers for building power stations outside their own districts, and thus utilizing the waste fuel of collieries. To produce cheap power from fuel, which has had to be carted to their own works, is out of the question. They also have not the necessary powers for supplying outsiders, and are, therefore, in the most unfavorable position for acting as power brokers or, intermediary for the buying and selling of power. What makes matters worse is that nearly every corporation has its own particular voltage and phase, so that it could not, even if it would, buy and sell power from and to others.

This condition of things is not likely to change until factory owners learn

that, with a proper system, they could easily be supplied with power at a cheaper rate than that at which they can produce it.

Gas From Coal

Another means of distributing power and economizing our coal resources is to convert coal into gas, distribute it in pipes and sell the by-products, thus encouraging agriculture and the coal tar industry. In a certain sense our corporations work on these lines, and even produce a third by-product—coke. The production and sale of coke might be encouraged more than it is, because it is a smokeless fuel; but here again we find the same conflicts as in the electrical field: corporation gas is too costly for cheap heating and power production, and producers of power gas are practically prohibited from introducing their pipes into towns.

It might be possible to combine the gas and electricity systems, then gas and its by-products could be produced from waste coal, and this gas could be used in internal combustion engines, to produce electricity. Unfortunately, however, the gas engine is not as reliable as might be wished, and it is also disliked because of the irregularities of its revolutions which cause flickering of lights and troubles in spinning mills. We have, therefore, to wait, but possibly not for long, for the perfection of the internal combustion turbine. At present the steam turbine seems to combine the greatest number of advantages; not only is its running very steady, but new designs are reported to be very economical.

The fuel economy question may, therefore, be briefly summarized by saying that hardly any improvement is likely to be effected in the economic working of boilers, for, as is well known, there is only a margin of about 20 to 25 per cent. to play with. Considerable pecuniary saving might often be effected by increasing the number of boilers, so as to be able to burn a poor and relatively cheap fuel if this can be got. For instance if, when best coal costs $5, dirty coal of, say, 75 per cent. heating value were obtainable for, say, $1.50 per ton, the coal bill would be reduced to one-half, but only if the local colliery can bring this dirty coal to bank and if the boilers are large enough to burn it.

Prime Mover Development

Our chief hopes will, therefore, have to be centred on engine improvements, for here large savings might be possible, because at present about eight units are thrown away for every one doing useful work. Improvements have been and still are being effected by inventors, and research workers have little scope for their activity. Research workers have already indicated very clearly that the internal combustion engine can attain a much higher efficiency than the steam engine, but the high cost of the fuel, either oil or gas, nearly balances this advantage, and constant engine troubles and repairs are both annoying and costly. Research workers have also shown that the turbine should be much more efficient than the reciprocating engine, but it is only comparatively recently that the efficiency of the steam turbine has equalled and slightly surpassed that of its older rival, and we look to inventors, rather than researchers, to reduce the remaining losses to a minimum, for the most convenient form of extracting power from coal is still the old method of burning it under a boiler. Central power stations are not limited in their choice to the steam engine for power production, and in view of the very high theoretical efficiency of internal combustion engines they very likely hope to see the internal combustion turbine brought to perfection.

From a national economic point of view, the combination of the internal combustion engine with electric distribution of power would seem an ideal one. Our collieries would then be encouraged to mine even our dirtiest coal. This coal would produce by-products for farmers and for the coal tar industries, and supply the engines with suitable gas, and our factories would receive their power at a lower cost than they could produce it.

ALBERGER MULTI-HEAD WATER HEATER.

MULTI-HEAD WATER HEATER

A VERY complete absence of the troubles usually experienced with water heaters of conventional design is claimed for the Alberger Multi-head Water Heaters, which are designed with the object of not only insuring an adequate supply of hot water, but of performing this service at a minimum cost for repairs and cleaning.

Although the closed heater of the water tube type has long been recognized as the most efficient type with regard to rate of heat transmission, its full measure of success has not been obtained heretofore by reason of such internal troubles as scale, corrosion, split tubes, leaky joints and heads, etc. In the heater illustrated herewith, every possible effor has been made, through the selection of proper materials and consistent design, to overcome these recognized defects.

All parts coming in contact with steam or water are of cast iron or copper; the shell, tube heads, water channel, and steam and water heads being of special cast iron of non-corrosive properties, while the tubes are of pure copper, which, being homogeneous, is not subject to splitting and other defects resulting from the segregation of brass.

All water and steam connections are on the body of the shell, avoiding the necessity of breaking joints to get at the heating surfaces. Straight tubes of small diameter are employed because of their high efficiency, which is still further increased through being provided with spral corrugations. The self-cleaning action due to the rotation of the water while passing through the tubes, maintains a high degree of constant efficiency.

Considerable interest centres on the use of floating heads into which the tubes are expanded at one end of the heater, provision for proper expansion being necessary to allow full benefit to be obtained from other features of the design. The difference of expansion between the initial and final tubes through which the water passes, is taken care of by dividing the tubes into groups, each group having a separate floating head at one end, the grouping of the tubes reducing the difference of expansion to a point which eliminates tube troubles

The Alberger Heater Co., Buffalo, N. Y., build this heater in capacities varying from 200 to 200,000 gals. per hour, and in various types for hot water service in hotels, laundries, office buildings, public institutions and factories.

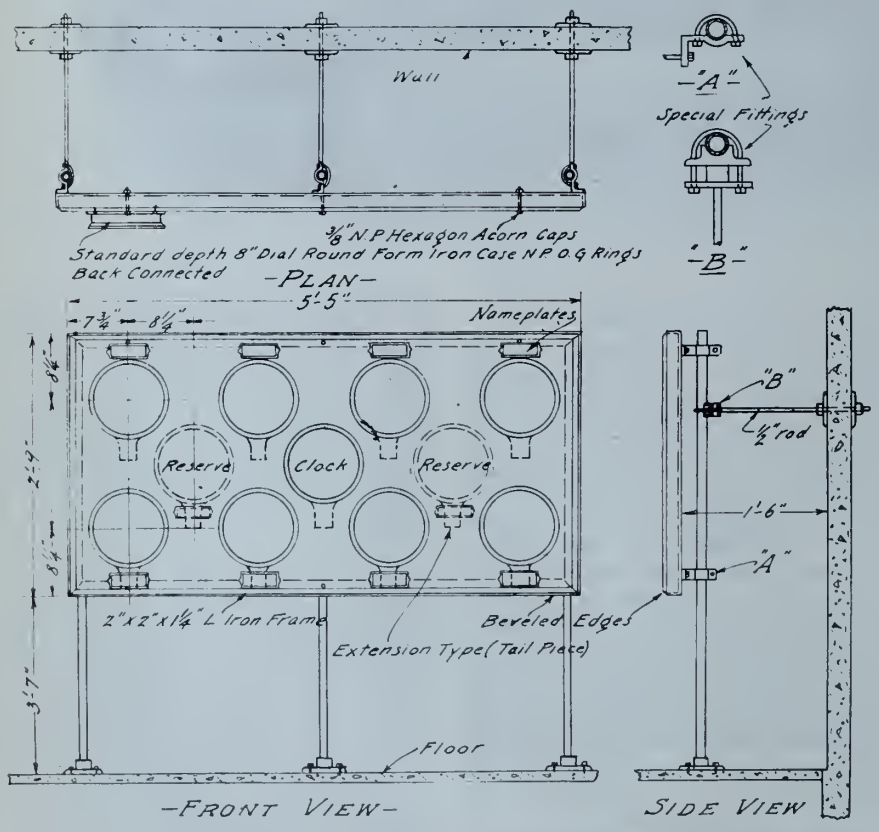
INDICATING AND RECORDING INSTRUMENTS FOR THE POWER PLANT

By T. W. R.

THE proper selection and installation of indicating and recording instruments for the power plant is a subject which is seldom given but a passing thought as compared to the operating apparatus, though nevertheless a deciding factor in the recording of operations, also in the finish and appearance of the plant. Such references in the specifications as are usually made are not in detail, and cover merely the material of the gauge board and general nature of the instruments. In selecting an instrument for a certain application, it is extremely important to choose from the many types the most suitable equipment for that particular application, taking into consideration not only the external features and the design of fittings and fixtures, but also the fundamental principles of construction and operation, which determine the accuracy and scale characteristics.

The Gauge Board

The gauge board itself should be free from flaws and seams, and have neatly bevelled edges, the standard for which is ½ inch. The bevel protects the edges from chipping. Usually a board of 2 ins. thickness is required, according to the size of same, and, in the opinion of the writer, this, together with all switchboards, should harmonize and be furnished preferably in dull black marine slate. To support the board uniformly, and proportion the stress upon same, the ends and sides should be enclosed for this thickness of board in a 2-in. x 2-in. x ¼-in. angle iron frame, thereby avoiding an undue amount of strain upon any one point. The board is bolted to the frame with finished nickel-plated hexagon acorn caps for the bolt heads showing on the face of the board, use being made of ¼-in. fillers to prevent the frames from projecting beyond the bevelled edges. The supports are shown in detail in the illustration and consist essentially of 1¼-in. iron pipe and cross braces thoroughly bolted to the frame and having ½-in. rods through the wall with flanges each side of the same. These are connected with special fittings as purchased upon the market, details of the latter being shown. The construction of the frame and supports should be neatly done. Several methods of support may be considered in accordance with the requirements of local conditions or preferences. those having no portion of the angle iron supports and braces showing below the board are desirable, though such are more costly and present a maximum of objectionable structural work as viewed from the sides. Allow a clear space of 18 inches back of the board for access to connections.



LAYOUT OF INDICATING AND RECORDING INSTRUMENTS FOR THE POWER PLANT.

Instrument Mounting

The instruments should be neatly mounted on the board, installing each with a clearance of about 2 in. between their overall outside circumferences and with a clear space along the outside edges of about 3 in. The board should be designed so that space will be available for the mounting of additional instruments, these often becoming necessary as the plant enlarges. All instruments on the board should be with back connection and have standard depth cases, uniform in size, design, material and finish, those having the name of the manufacturer, etc., in raised or large type upon the front of the same, are, in the writer's opinion, detrimental to the good appearance of the board. Dials 8 inches in diameter with round form iron cases and nickel-plated O. G. rings, are more generally used. Instruments of other than round form are indicated upon the sketch as shown dotted. While not as desirable from the standpoint of good appearance, they are claimed to be more accurate, due to the arc described by a pen pivoted from a central point in an extension below the dial. In a round form instrument the pen is pivoted from the side and all working parts are necessarily somewhat smaller. being enclosed in the round case, though by simplifying such parts their use is permitted through the taking of less space. The clock should be of size, finish, etc., which will correspond in all respects to the instruments, and should be mounted on the centre of the board. A clock of round form so located will harmonize with instruments of any form though if desired a clock with a tail piece may be obtained which will be in keeping with the instruments of the extension type as shown dotted.

Each instrument upon the board should have its respective connection indicated by letters approximately 13/32 of an inch in height (with 3/16 in. space between lines), on white opal glass nameplates 1⅝ in. x 4¼ in. in size. These are enclosed in nickel-plated brass holders. The letters are depressed on the plates and filled with black enamel rubbed in, as is usually done in connection with the ordinary brass nameplate. They may be in raised type if preferred, but such are liable to destruction by chipping off. The white opal glass presents a good appearance against a background of dull black marine slate, while the letters may be in any colors corresponding to distinguishing standard colors for the painting of the plant piping system. Where wooden boards painted black are used, letters may be painted thereon in prominent, white, distinctive, letters of a size easily read at a distance.

Connections to gauges at the board should be of brass pipe, and fittings nickel-plated where in sight, with a union cock and syphon water seal placed in a convenient position on each connection, the latter forming a pocket of sufficient capacity to fill the spring with water and maintain the temperature of the same below 140 degs. Fah. Ordinarily only the recording instruments are located upon the board, with such extra devices as Venturi recorders installed adjacent thereto flush with the board top and front. It may be advisable to locate all of these in the engineer's office, visible from the outside to others of the operating staff through windows. The usual instruments are those recording the steam pressures of the low (back pressure upon the exhaust lines), intermediate and high (boiler steam header), and the temperatures of the outside atmosphere and boiler feed water. It is very often a wise precaution to allow provision upon the board for future instruments.

Eight Day Records

All recording instruments should be designed for 8-day movement, and each equipped with a non-corrosive, non-spilling pen, automatic release pen lifter, and furnished with a bottle of special red ink and ink dropper. Instruments which have a micrometer adjustable pen arm are desirable for necessary adjustments due to water column, etc. The automatic release pen lifter keeps the chart and instruments neat and clean, free from surplus ink, and allows the free use of both hands. Closing the door with the chart in place will automatically release the arm and cause the pen to return to the chart, thus eliminating the possibility of leaving the pen out of commission. Recording instruments may be obtained in moisture, dust and fume proof cases, or with water-proof cases, where necessarily submerged in a liquid.

A year's supply of charts, say 400 for each instrument, to allow for wastage, should be kept on hand, and these should be arranged for 24-hour records with the exception of the 7-day charts for the thermometer recording the temperature of the outside atmosphere. All charts should be uniformly printed with permanent figures, graduations and inscriptions, which may be easily read at a glance, they should neither blot nor smudge, and should have accurately trimmed outer edges with a hole correctly pierced in the centre of the chart. In the selection of graduations, only those necessary for the record desired should be used, for with a lesser range a closer record and reading may be obtained. Suppressed scale graduations may be used, as, for instance, the range 100 to 150 pounds, rather than 0 to 150 pounds. The lower pressures under which the instrument could operate are eliminated from the chart, and the important and effective working range spread out to utilize the full length of the scale and thus obtain closer graduations.

Charts Range

They are especially desirable in large power plants where it is desirable to show the fluctuations in boiler pressure on an enlarged scale, and may be advantageously adopted for many other purposes. Obviously charts should be of a range sufficient to record the maximum and minimum pressures. For a neat appearing record, a chart of a specified range may be selected as desired upon which the average reading will run half way between the inner and outer circumferences of the chart. Standard or stock charts, those more generally used for ordinary conditions, should be purchased, as these are more readily obtained when a new supply is required. When impossible to obtain on standard charts, graduations as desired, use the nearest standard of greater range.

Smoked charts may be obtained which eliminate all friction between the recording arm and the surface of the chart, as the tip of the recording pen arm is only in contact with the surface of the chart momentarily at intervals of ten seconds, the pen being free and clear of charts between contacts. In this way, a white record line is made on the semi-transparent smoked chart, and, after the record is complete, this is "fixed" by dipping the chart in a fixative solution. Somewhat similar in their action are the frictionless intermittent ink recorders which produce a record line by a succession of dots. Charts may be obtained in conformance with almost any requirements and many possess such novel features as the day and night border charts which designate the night section by a black border, while in the case of the 7-day charts such portions are shaded. Reverse scale charts, that is, reading from the outer edge toward the centre, are often used where apparatus is operating under a low pressure, and it is desired to obtain close time readings, with at the same time an instrument that will withstand a high pressure if occasion should demand it.

Ordering Gauges

In ordering recording gauges, to allow for calibration of the instrument at the factory, state the purpose for which they are to be used, maximum pressure to which the gauge will ever be subjected, average working pressure to be recorded, and the minimum pressure of which it is important to have a clear record. Similarly, for recording thermometers, state the purpose for which they are to be used, distance of the bulb from the instrument, maximum temperature to which the sensitive bulb will ever be exposed, average working temperature to be recorded, and the minimum temperature of which it is important to have a clear record. Each recording thermometer should be supplied with sufficient flexible, preferably bronze armored, connecting tube with a bulb of proper dimensions (according to the fitting into which it is to be inserted, usually an elbow), having a union connection and bronze socket protected by a separate bronze socket.

Recording thermometers may be obtained in several types, as for instance, those with which any temperature changes that may take place along the connecting tube or at the instrument do not affect the accurate recording of the true bulb temperatures. It is often desirable to install in engine rooms and offices thermometers for recording the temperature out-of-doors. At certain times of the year the room in which the instrument is located may be hotter or colder than where the bulb is located. With some types the temperatures at the bulb must be higher than at any other point. Where a uniform scale is desired, a type may be used which, having a larger bulb and consequently a greater mass of metal, will not so quickly respond to changes, but which is still much more sensitive than the ordinary mercury thermometer. Its sensitiveness can be greatly increased by the use of a bulb with radiating discs. The capacity of the bulb being very large compared with the rest of the filled parts of the instrument, any variation of temperature at the parts other than the bulb have no appreciable effect on the record.

For thermometers recording at the board, the temperatures of the outside atmosphere, it is necessary to install at the nearest point an extra sensitive bulb with radiating discs. These should be located where a true reading can be obtained and enclosed in a weather-proof protecting lattice box properly secured to the outside wall of the building. The bulb is extra sensitive to changes of temperature as the lattice box permits the atmosphere to circulate freely about the bulb and the radiating discs.

Indicating Thermometers

The foregoing remarks relative to size, design, uniformity, etc., of recording instruments, are intended to apply also to instruments of the indicating types. These are usually distributed to read directly from the points to which connections are made. The face of each gauge should be distinctly marked to indicate the nature of its service. All gauges, indicating or recording, should have a globe valve in each connection close to the main, also a gauge cock close to each gauge with a pet cock be-

tween. An additional pet cock is required in the lowest point of the drop leg outside of the stop cock. Connections should be made to gauges in such a way that no water will collect in gauge pipes, and so cause a false indication on the gauge, and be so fitted that the instruments will be in operation at all times. The necessary adjustments for correct readings should be made.

A gauge located in a surrounding atmosphere of intense heat should be installed with wooden blocks placed between the instrument and the frame to which it is attached. This prevents in part, the transmission of the heat by conduction to the gauge itself. To avoid mechanical injury, etc., it is desirable to use an indicating gauge in which the entire movement is independent of its case. Those reading to indicate pressures of 50 pounds and over should be provided with double Bourdon tubes. This allows the use of a tube of heavier construction, being essentially a high pressure gauge especially adapted for service on machinery or apparatus where there is more or less extreme external vibration, or violent or rapid fluctuations in pressure. such as on a locomotive or for water service, etc.

Durability Feature

For greatest durability, a gauge should be graduated to double its working pressure. With certain types of Bourdon springs consisting of flat section tubing, gauges will be satisfactory when graduated to one and a half times the working pressure, under ordinary conditions. It is a well-known fact that no mechanical instrument will give good service if worked to its capacity continually. For this reason, if a gauge is graduated to about working pressure, the spring would very soon give out. Furthermore, nearly every user of gauges has over-pressure occasionally, and if some gauges are subjected to pressures much over the dial graduation, the spring will take a set.

Auxiliary Spring Pressure Gauge

The auxiliary spring pressure gauge has a small coil spring in tension, the functions of which are to return the free end of the gauge spring to its original position, when pressure is removed, thereby offsetting any tendency of the spring towards a permanent set and eliminating to the greatest possible extent the whipping of the free end of the gauge spring under excessive vibration.

Indicating thermometers are made with 7 in., 9 in. and 12 in. scales, 9 in. scales being generally used with graduations by one degree dependent upon the range desired. Anything above two degree graduations prohibits close reading. The thermometers should each be equipped with a nickel-plated case, moveable protecting shield, brass swivel nut, bulb and separable socket of sufficient length and a cap with retaining chain. The separable socket is a protection to the thermometer against corrosion or other injury, and permits the instrument to be readily removed when desired without shutting off pressure or emptying the vessel. Thermometers are manufactured of straight or side angle pattern, left or right, or inclined to nearly any degree to suit location.

BELT DRIVE TROUBLE

I AM having trouble with a belt drive which I would like you to advise me about. The line shaft is perfectly straight and level and the machine is also level and properly squared up with the shaft. The machine pulley is 15 in. dia. and the line shaft pulley is 6 in. dia., with 6 ft. centres. When the belt is crossed one way it runs over on the tight pulley and will not stay on loose pulley without belt shifters and when crossed the other way it runs over on loose and will not stay in tight pulley. I would appreciate an explanation so that I may cure the trouble if possible.—B.W.C.

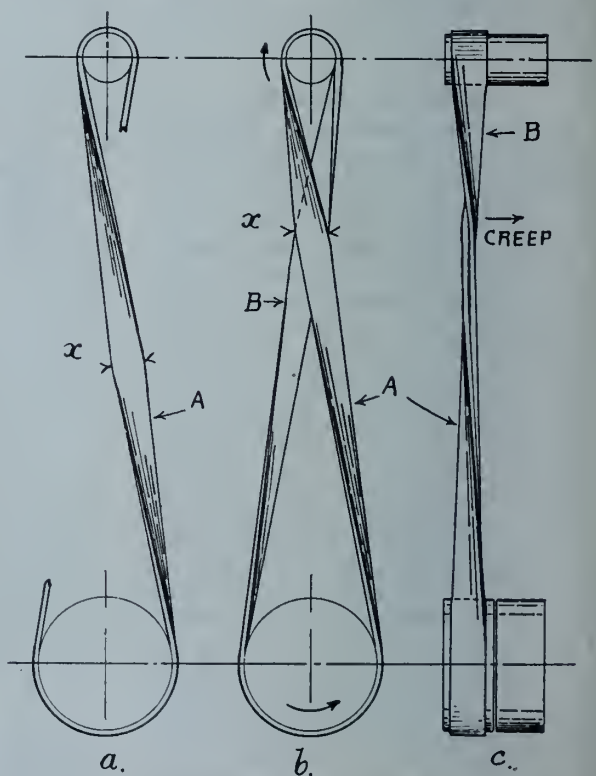
The trouble is due to one of the following conditions being near the limit, with regard to the others:—The centres are too close, or the belt is too wide, or the difference in diameter of the pulleys is too great. The accompanying diagram shows how these points affect the behaviour of the belt as described. The arrows indicate direction of movement, A being tight side of belt, and B the slack side. Sketch (a) shows the shape of A before B is in position. It will be noted that the widest part (x) is at a point midway between where the belt leaves the pulleys. When the belt is all on, the two sides press against each other so that point (x) is moved upwards, as shown in sketch (b). The tendency of A is therefore to twist in a left-handed direction, pressing B away from the reader, the reverse action being exerted by B, but the fact that A is the tight or driving side of the belt causes B to yield more than A, so that in sketch (c), side B will run onto the tight pulley with a gradual creep to the right as complained of. If the belt be crossed on the opposite hand, the reverse action will take place, as complained of. In order to dispense with belt shifters, it would be necessary to crown the faces of the tight and loose pulleys as much as possible, run with a thinner and narrower belt, increase the distance between centres or increase size of pulley on line shaft. By trying these suggestions as far as possible in rotation you should manage to cure the trouble.

PLATE WELDS IN TENSION

A WELD in tension is always an indefinite quantity as regards resistance to rupture. If well made, its strength may approximate to that of the parts joined, but in most cases it is difficult to assign a definite value to the effective strength, as can be done in the case of riveted joints, and for this reason riveted joints are to be preferred wherever riveting is practicable. It is necessary that vessels with welded joints should have a higher factor of safety than those constructed with riveted joints, and where welding is adopted it is essential certain precautions should be followed.

In recent years, fusion welding by means of the electric arc and by the gas blow-pipe system has ben largely used in constructional and repair work, while some makers of small vessels, for use in the storage of air and gas under pressure, have used one or the other of these systems of welding for the joints securing the different parts of the vessel together. Experience has shown that fusion alone cannot be trusted to unite the parts, and that hammering is indispensable to the formation of a reliable weld. In preparing the parts to be joined, their edges should be bevelled so that a V-shaped notch is formed at their junction. This should be filled bit by bit with the fused welding metal, and the parts hammered whilst at welding heat. If this is done there is a better chance of obtaining a sound and homogeneous weld.

John H. Bunting, joint manager of Bruce Peebles & Co., Edinburgh, Scotland, has been appointed general manager of the company.



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Vol. X. MARCH, 1917 No. 3

PRINCIPAL CONTENTS

Domestic Water Filtration Plant, City of Montreal, P.Q..... 49–55
An Eighteenth Century Pumping Engine 55–56
High Pressure Steam Stop Valve Design and Construction.. 57–60
Blow-Off Tanks for Steam Boilers 60–61
Steam and Its Generation 62–65
Steam Power Economics.
General 65
Multi-Head Water Heater.
Electricity and Hydraulics 66–68
Indicating and Recording Instruments for the Power Plant.
General 68
Belt Drive Trouble....Plate Welds in Tension.
Editorial 69
Our Present Efforts a Future Asset.
The Operator's Point of View 70–71
Friction Clutch for Countershaft....Obtaining Draft Without High Chimneys....Globe Valve Experiences ....Line Shaft Troubles....C.A.S.E. Organize at Sudbury.
Question and Answer Series 72
Steam Power Plant Auxiliaries (Advtg. Section) 42–45
Steam Separators—II.
Trade Gossip, Catalogues, Book Reviews 45

OUR PRESENT EFFORTS A FUTURE ASSET

HISTORY has been made in more ways than by feats of arms since the memorable appeal for shells was made by Sir John French when in command of the British forces in France. Not the least notable of developments incident to the then crisis has been the steady increase of munitions output by Canada, with its resulting influence on our future status in the manufacturing world, and which is yet possible of little more than approximate estimation. One fact, however, stands out in strong relief amid the meantime din of industrial effort, viz., our reserve strength in men, money and material wealth.

In pre-war days the productive capacity of the Dominion, in strictly mechanical fields, was of a very limited nature, due in part to the fiscal policy which seems to be indispensable to young industrial nations during the embryonic stages of developing their natural resources and consolidating their commercial and manufacturing enterprises. Had times such as these been foretold in all their present reality, their improbability would have been readily admitted rather than otherwise.

With reference to our munitions manufacture, it may be said that this in itself is ample evidence of the first item of reserve strength, i.e., men. The use of the word "men" is, of course, somewhat ambiguous now, in view of the successful and increasing employment of women, and when we say successful, we mean more than getting out shells or fuses on time. By successful, we mean the utilization of women help in such a manner that mutual satisfaction with the results obtained will insure a future continuance whenever and wherever opportunity offers. Among the contributing factors may be mentioned equitable remuneration, facilities enabling their arrival and departure from work to be made in a manner consistent with reasonably refined custom, and the shortest hours possible that the nature of the work permits.

The successful utilization of labor from so many previously unsuspected directions is one feature, however, which is destined to have a lasting influence on future industrial conditions, not only in Canada, but elsewhere. Abnormal effects are usually the result of abnormal causes, which, if maintained long enough, come to be regarded as normal. While many of the present abnormalities will disappear in due course—even now the adjustment process is abundantly evident—they will be replaced by others of a more stable, permanently beneficial nature, for which the present period of strenuous effort will have provided the preliminary preparation.

Another noteworthy and intensely personal factor, and perhaps more important than that of actual service, is the mechanical resourcefulness which has been displayed by the staffs of hundreds of factories from ocean to ocean. In the ordinary course of events, thousands of mechanics would never have had occasion to worry about methods and devices of production to the extent at least that these latter have had to be applied in solving satisfactorily munitions manufacturing problems. Their experience with products of their own brains and hands in competition with those of erstwhile competitors and foreign specialists has given them a confidence in their own ability and a capacity for estimating and appreciating at their true value the products of others.

It has enabled them and others to judge our engineering products from every angle, and, while the ultimate growth of the country precludes the possibility of being entirely independent of foreign machinery builders, conditions during the last two years have been such that a fuller, stronger, wider, and more distinctively Canadian metal-working industry can be confidently looked forward to.

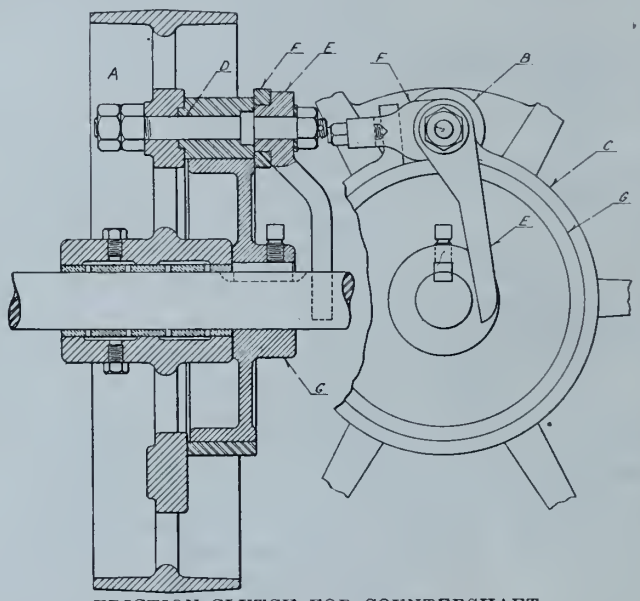
Vast though our expenditure on war has been, it must not be forgotten that our ability to meet this is due to national credit, which in turn is founded on national resources. Without the first and last of these—men and materials—our credit might long ago have ceased to exist. The recognition by the Government of the necessity for scientific research, and subsequent industrial development, will result in an ever-increasing appreciation of Canada's natural wealth. The extent of our dependence on the United States for essential materials would be brought home to us, perhaps more vividly, if the entrance of that nation into the European conflict resulted in prohibition or even restriction of much meantime exported material.

The Operators' Point of View

FRICTION CLUTCH FOR COUNTERSHAFT

by J. H. R.

THE matter of suitable drive for machine tools is an important factor not only in the production of munitions but in that of other manufactured articles as well. While recent applications of machine drives do not bear directly upon the munition problem, many of these have been developed to overcome difficulties arising out of this industry. The clutch here shown was designed and constructed by the John McDougall Caledonian Iron Works, Montreal, for the purpose of increasing the efficiency of shell turning lathes. Contrary to the general practice of an expanding spring clutch ring, the method adopted in this device has been to use a spring ring that closes on the outer diameter of the driving hub G. One end of the spring clutch ring C is secured firmly to the boss B of the loose pulley. The operating lever arm E, when forced outward by the slip sleeve (not shown), draws the two ends of the clutch ring C together, gripping the driving hub G. With the interior ring, there is generally a tendency for the clutch to creep, this being caused by the centrifugal action of the spring ring. With the type here shown, the motion, when clutch is out of action assists in preventing contact between the two friction surfaces.



FRICTION CLUTCH FOR COUNTERSHAFT.

OBTAINING DRAFT WITHOUT HIGH CHIMNEYS

By E. T. S.

ON page 28 of your issue of February is a short article entitled, "Obtaining Draught Without High Chimneys," that merits, in my opinion, more than ordinary attention, by reason that the author either has discovered something radically new in draught producing apparatus, or else he omitted to localise the case in question, in which case, the term "ordinary practice" is out of place.

Now, it is a fact that in "ordinary practice" the purpose of a chimney or stack is to "make the fire burn," in other words, to provide sufficient draught to produce complete combustion of the fuel under the boiler. Also, in the second case it carries off all obnoxious consumed or unconsumed gases. So far, I agree with our friend who now remarks, "so far so good, but this leaves in many cases much to be desired." I would like to ask what it is that is left so desirable? To continue, we read that the most efficient heating is secured by reducing fuel to carbonic acid gas. Quite true, but to produce this state in the furnace, our friend states that it is necessary "that large volumes of air must be drawn through the fire at comparatively low velocity." This statement is extremely broad, even omitting the fact that the information given is "general." We know that, for every pound of fuel consumed, a certain determinate amount of air is necessary for complete combustion. Perfect combustion is attained when the correct amount of air is admitted through the fire and also over the fire.

The next paragraph in the article says that "The best method of providing the necessary air for combustion is by means of an exhaust fan." Before proceeding further, I would like to ask, what the difference between the two draughts is to the furnace, supposing both are designed to produce the same pressure, or, whether our friend considers that a chimney draught is superior to a fan draught by reason of its origin alone. The question is absurd, because if either be designed to give a certain draft in inches, the furnace cannot detect the difference.

The subject is a live one to-day, even as to the merits of the two systems. The fan system is favored chiefly on account of the low installation cost. The chimney is high in first cost, but has a maintenance cost of practically nil; on the other hand, maintenance cost of an induced fan system is endless. In this country where we are subject to severe winter temperatures, most of us drive our boilers pretty hard in the winter. The fan is speeded up above ordinary, and, if anything happens it is liable to be serious. The chimney acts in a way, more or less automatically with you. The intensity of the draught depends on the difference between the inside and outside temperatures, and so up to a certain point the draught increases as it gets colder.

I do not pretend to understand our friend's system of stacked brushwood kept watered, unless it is intended at the air intake end of a forced draught system. Perhaps he will enlighten me?

I have written more than I intended, but it must be obvious to anyone that now-a-days a stack is not just "guessed at" for size or anything else, any more than an induced draft or forced draft system would be installed so thoughtlessly. It is the cost, the ultimate cost that counts, and these involve careful calculations and painstaking consideration.

GLOBE VALVE EXPERIENCES

By J. E. McCormack.

WITH regard to globe valve experiences the writer likes to have two globe valves on the steam supply pipe to the injector or pump, just on the same principle as one likes to have a globe between the check valve and the boiler, or a stop cock between the boiler and the throttle, because if one fails he has the other to "fall back on," as the phrase goes.

Some years ago he was in charge of one of those plants having only one globe between the injector and the boiler steam space. This globe was of the type in which the face was an internally threaded member and was screwed onto an externally threaded member which in turn fitted behind a shoulder on the valve stem. All went well for a few weeks, then one morning the face dropped from the stem and lodged in such a way as to render the injector inopera-

tive. As there was no other feed-water system installed, and only one boiler used, there was no option but to get the steam off, fix the valve, and raise steam again, thus causing a delay involving more or less financial loss to the proprietor, and which could have been avoided had there been another valve next the boiler with which to shut back the steam while the defective one was being overhauled.

Choosing a Valve

It was then decided that an additional valve should be in for meeting such an emergency should it recur, and the writer was asked what make of valve he would prefer. It was only natural that he be expected to name what was then the valve most advocated by old hands, but he was young, enthusiastic and self-willed. He wanted one which, for holding the face in place, did not depend on a nut or screw which might come loose and drop the face, or, if made too tight, would perhaps stick and refuse to budge without breaking. A valve answering to these requirements had been described in your publication. The local dealer did not stock them, but a look or two through the advertisement section disclosed the whereabouts of a sales house, and a few different sized valves and discs were ordered by letter. The only tool required when changing the discs is a wrench that will remove the bonnet; this done the old disc can be easily removed from the stem by hand and a new one slipped on. When the bonnet is returned to its place it is impossible for the disc to get out of position.

Emergency Babbitting

After a time it was found that the supply of discs for one size of these valves was nearly exhausted and to make it hold out a little longer (owing to no local dealer stocking them as aforementioned), the writer took a cue from the soft metal faces of some lubricator plugs. The old asbestos face was dug out and its place filled with melted lead. This lasted for two days, at the end of which time it had squeezed out too much. Melted babbitt metal was then tried, and as it gave very good service it was used on this size of valve for some time. An acquaintance tried the babbitt on a make of valve which used a nut to hold the face in place and effectively locked the nut by pouring in enough metal to cover the nut.

Although the writer was, and is yet, well pleased with his chosen make of valves, he has known them to be criticized by other operators, each of which had a preference of his own for some particular make, but on one occasion when talking with an engineer about valves in general, the engineer remarked, "I like those —— valves. For one thing, they are a valve you are never stuck with. The discs are easily changed, yet won't come off unexpectedly, and if you should happen to run out of discs you can remove the old face, pour in some babbitt, true it up a bit and go on again." Now, my object is not the boosting of any particular brand of valves, but what I want to impress is that this babbitt habit has helped out of difficulties at times and a few men have begun to look to it as one of their stock emergency measures. With this fact in mind we are ready for another experience, which came to the writer's knowledge just recently.

Conditions Must be Studied

The globe on an injector steam pipe was bad and no proper face for that make of valve readily procurable at the time, a few days' delay being normally unavoidable under existing circumstances, and so the operator tried the babbitt scheme for the first time. His boiler was an upright one with this globe placed close to it. Before being in use long his injector balked and investigation proved that some of the babbitt had melted and been carried down into the injector steam jet. Evidently some of the metal had also lodged in the elbow, for after a reliable face had been inserted the injector was twice put out of action by plugging with babbitt. The brand of babbitt used may have been rather easily fused, but the writer's personal theory is that since the boiler was an upright one, the steam became at times sufficiently super-heated to melt babbitt. Anyway, this latter experience proves that though some have been helped by thus using this metal it may perhaps be worse than useless wherever any degree of super-heat may even possibly exist, and "by the same token," when trying out only one valve of any make and in comparison with other valves in service it may, if placed as above-mentioned or in any other position where super-heat may get to it, appear to use softer discs than other valves when in reality it is being put to a more severe test than is the valve or valves it is being compared with, yet without the operator suspecting that such is the case.

LINE SHAFT TROUBLES

By H. Westwood.

UNDER this heading there appeared an article in a January issue of your publication. It just serves to remind me of an engineer in a neighboring works to where I was operating an electric plant. The day came when my neighbor engineer had to put a new drive belt on the engine, which was a 20 in. x 36 in. with a 14-ft. fly-wheel.

The old belt was taken off on Sunday morning and the new one put on. Monday morning arrived and found the would-be expert at the throttle. When the engine began to turn over, the belt did not run in the centre of the pulley, but far enough over to the right side to rub the wooden partition that had been placed there to prevent anyone falling into the wheel pit.

"Well, she will have to go till Sunday," was the explanation from George, "there is not enough time at night to undo the splice and re-splice it." Each day that week found the belt rubbing the partition harder until it had nearly worn it through, and as each day arrived, George had a new idea as to what might be the trouble.

Blaming the Line Shaft

One thing he was sure of, and that was the drive shaft, which was about 150 feet long, was out of line. Next Sunday arrived and with it a gang of men to line the shaft. Some understood what to do and some didn't; however, the shaft was lined and Sunday night found a tired lot of men and the shaft 4½ inches farther from the engine line on the extreme end. Monday morning came and the engine was started up, but, alas, no improvement in conditions of the belt running in the centre, and to make matters worse, several boxes burned out on the line shaft. A couple of nights that week were spent in fixing up the boxes all along the line shaft.

The following Sunday an attempt was made to jack the engine around on the bed, but did not meet with the desired success. The belt by this time had stretched considerably, and some time during Tuesday morning of the third week it took a notion to flop over and run with its back on the driven pulley. To the surprise of George, when he came to the shop he saw the belt running as nice as could be, right in the centre of the pulley, and with all haste he entered the engine room to know why and found out.

"Well, I'll just take it off next Sunday and tighten it up and it will he all right!" But George never had the chance, for the following Thursday the place was burned down.

C.A.S.E. ORGANIZE AT SUDBURY, AT a meeting of Stationary Engineers held in Sudbury, Ont., on February 28, a branch of the Canadian Association of Stationary Engineers was organized. Officers were elected and installed for the remainder of the current year at a meeting held on March 13. A Lodge Room has been secured in the Temperance Hotel Building, Station Street. W. H. Anger and J. H. Hale, executive secretary were largely instrumental in arranging the details connected with the establishment of this new branch, the former carrying out the initiation and installation ceremonies necessary for members and officers respectively. The officebearers are as follows:—Past president, A. A. Wigley, president, J. J. McCaffrey; vice-president, J. A. Peters; secy-treas., A. I. Riddell; recording secy., R. S. Wright; conductor, A. Laberge; doorkeeper, W. E. Massie. The membership of the Lodge in addition to the foregoing includes J. E. McFarlane, C. Doolittle, W. Keays, G. W. Dale, P. O. Deseron, R L. White, F. Lumley, C. Blacklock.—Brennan.

Pop of Safety Valves.—By "pop" of a safety valve is meant the instantaneous rise to almost full opening after the first tendency of the valve to move from its seat, or simmer. A satisfactory "pop" is essential to a successful safety valve. Absence of "pop" will mean a prolonged simmering of the valve which will soon score both valve and seat, especially if steam is superheated.

Question and Answer Section

Pump Suctions and Discharges.—Why is it, that in a centrifugal pump we get the suction and discharge openings of equal diameter, whereas, in the duplex type, or, in fact, any type of pump other than the centrifugal, the suction is the larger of the two? With the same lift, does equal friction exist in the suctions of either type?—Telco.

Friction losses in a centrifugal pump have a much more serious effect than in the case of a duplex or positive action pump with pistons or plungers. Centrifugal pumps attain their highest efficiency at a certain predetermined speed and if pipe sizes are reduced, the increased velocity results in considerable friction loss which reacts on the output capacity of the pump at given speeds. Hence both suction and delivery are as large as commercially practicable within reasonable limits, but always with a view to running the pump at its point of maximum efficiency. Positive types of pumps on the other hand will work at any speed from maximum to minimum, and in ordinary conditions seldom work at maximum speed continuously. Economy in discharge piping is therefore possible with positive pumps which could not be done with centrifugal pumps. The suction effect in either type of pump is identical so far as pipe friction is concerned, so that the maximum diameter permissible is adopted in nearly all cases, the pipe friction being the same for equal velocities of water.

* * *

Steam Heat Pressure.—Is there economy in carrying a high steam pressure? Will you please let me know what is the most economical pressure to carry on a boiler installed to heat a business block? Can carry from 50 to 160 lbs. per sq. inch gauge pressure. That on the radiators is, however, below atmospheric pressure.—A. C.

High steam pressures say up to 150 lbs. per sq. in., are frequently used in connection with the heating of public institutions, office buildings, etc., where floor space is valuable, as by generating at a high pressure and reducing to a few pounds pressure, the steam is delivered in a superheated condition which enables it to travel through considerable distances of piping before condensation begins to take place. Installations of this type necessitate the use of steam traps or pumps for returning the water of condensation to the boiler, whereas in small buildings and residences a gravity system is generally used, with a steam pressure of from one to five lbs., the condensed steam returning by gravity to the boiler, which is below the level of all mains and radiators.

As a result of such conditions there is more perfect combustion, better circulation, greater efficiency of heating surfaces, etc., high pressure boilers, particularly of the water tube type, are most economical if in constant use. Small installations with occasional attention, however, cannot be more suitably equipped than with low pressure boilers with pressures up to ten or twelve pounds.

* * *

Offsetting Lower Boiler Pressure.—My engine travels at the rate of 98 revolutions per minute, but my boiler is no longer rated to carry its original pressure—only 70 lbs. per sq. inch now. This gives us too much wet steam. I would like to know if increased efficiency can be secured by speeding the engine up to 105 revolutions per minute, and lagging the pulley on the main line shaft sufficiently to retain the present speed of the latter?—M. W.

A reduced rating in your boiler pressure will not prevent you from obtaining as much power from it as previously, if you do as you suggest. The steam pipes should be well covered and a separator installed next the engine, which, if run at 105 revolutions with an increased diameter of pulley on line shaft to keep shaft-speed constant, would have an increased efficiency which would offset the 10 or 15 lbs. drop in boiler pressure. Theoretically, from 98 to 105 revs. per min. equals an increase of approximately 7 per cent. As the power of an engine is directly proportional to both speed and pressure, this increase in speed equals a drop in pressure of 7 per cent., or from 75 to 70 lbs. We presume, however, that the former pressure was higher than 75 lbs., hence the suggestion to regain the difference in power reduction by improving the economy.

* * *

Lubricant Feed Pressure.—What would be the pressure at the discharge end of a lubricating hose on a boring machine using gravity feed, the supply tank being located 30 feet above the floor?

A column of water one foot in height and having a cross sectional area of one square inch will weigh .434 lbs. As the height of the discharge above the floor will be about 3 feet, the actual head of water will be 27 feet; therefore, the pressure at the machine will be approximately .434 $\times$ 27 equals 11.7 lbs. per square inch.

* * *

Pump Suction Lift.—An engineer friend of mine claims that a pump when equipped with a check valve at the suction end of the intake, and having the intermediate piping flooded by means of a priming apparatus, will lift or draw water vertically and without interruption from an indefinite depth, that is, a depth greater than 34 ft.; for example, say, 40 ft. I claim that under no circumstances, providing, of course, that atmospheric pressure is normal to that of sea level, will a pump draw water from a depth greater than approximately 34 ft. Which is correct, and why?—W. R. H.

The maximum height through which it is possible to move a column of water depends entirely on the pressure of the atmosphere. If your friend could get this first principle of suction lift clearly into his mind he would immediately see the error of his statement and also understand why putting in a check valve will not increase the lift, but rather decrease it. All pumps lift water by exhausting the air in the suction pipe above the level of the water supply. By removing this air, the water is free to rise in the pipe as the result of atmosphere outside pressing on the body of water being pumped. It stands to reason, then, that the water will not rise any higher than necessary to balance the pressure of the atmosphere. In round figures this amounts to 15 lbs. per sq. in., decreasing with the height above sea level. The height of the water in the suction pipe, therefore, will be that which gives a pressure at the lower end equal to the atmosphere. A column of water 1 in. square and 12 in. high weighs 0.434 lbs., so that if 15 lbs. be divided by .434, the result will be the number of feet necessary to give 15 lbs. pressure. $15 \div .434 = 34.5$ ft.

In the case of a plant in a high part of the country, the atmospheric pressure might be only 12 lbs. per sq. in. and $12 \div .434 = 27.6$ ft. The check valve referred to is inserted in the suction pipe to prevent the water dropping back down the pipe should any air enter when the pump is stopped. It is a necessity with centrifugal pumps and reduces the lift by an amount equal to its weight in lbs., divided by its area in square inches, and this again, divided by .434, the answer being in feet.

A CONTRAST

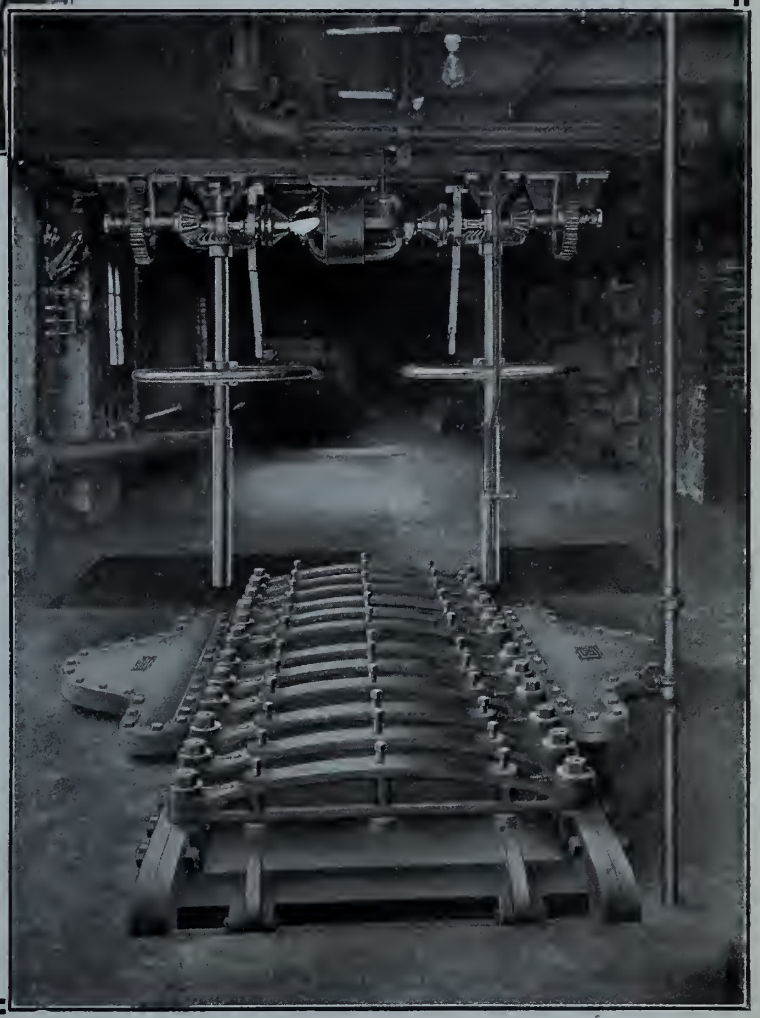
The photograph opposite shows one way of keeping such debris as sticks, leaves, etc., from being drawn into your pumps, condensers and other apparatus.

A diver is engaged periodically to go down under the water to remove the debris that accumulates around the strainer on the inlet of the intake pipe.

The photograph below shows another way of keeping debris from entering your plant via the water intake plan.

A Twin Strainer is used to catch all solids, such as fish, sticks, leaves, twigs, stones, etc., that are carried along in the water. These solids are retained in the baskets of the Strainer, where they can be readily removed at any time without interrupting the flow of water, for when the water is flowing through one set of baskets the other set is out of service.

Motor operated Twin Strainer in 42-inch suction line to condenser—Toledo Railways & Light Company. The motor and operating apparatus is overhead, where it will not be damaged during high water seasons.



Some of the many advantages of the Twin Strainer installation will be readily apparent.

The most obvious one is the convenience of cleaning, which is an assurance against interruptions to the service. The Twin Strainer can be cleaned once or forty times a day, as conditions demand. It can be located in any convenient place inside the plant, where it is accessible at all times.

Twin Strainers will strain water, oil, or any other liquid, and are furnished for either motor or manual operation, in all sizes from 1 to 48 inches inclusive. The basket equipment is varied to suit conditions. Complete information in Bulletin "A." A copy is yours on request.

Elliott Company

6902 Susquehanna St., Pittsburgh, Pa.

If any advertisement interests you, tear it out now and place with letters to be answered.

STEAM SEPARATORS.—II.

WHERE boiler plants are operated without proper attention to water level, or where bad water and overloads are unavoidable, large amounts of water are constantly being passed into the steam main forming

FIG. 11—VERTICAL "WELDERON" RECEIVER SEPARATOR WITH INTEGRAL PIPE EXTENDING THROUGHOUT.

what are termed "slugs" of water which cannot be separated by ordinary separators which deal almost entirely with entrained or suspended moisture. The removal of these slugs is necessary if damage to the plant is to be avoided, and the receiver separator which has been developed to cope with these conditions. Some of these devices consist of regular type separators provided with additional receiving capacity, while others are specially constructed with a view to providing ample capacity as a feature of the design.

Welderon Receiver Separator

Two types of this separator are illustrated, the vertical in Fig. 11 and the horizontal in Fig. 12. They consist essentially of a part of the main steam header, provided with a diaphragm and with inlet and outlet ports, and surrounded by a steel plate body or receiver. This construction is adopted to avoid any reduction in the strength of the steam main, which is carried without break from boiler to prime mover, thus completely eliminating any localization of expansion or contraction stresses, or any shock load due to vibration. Inside the receiver body, the continuous pipe is divided into two distinct portions by a steam-tight diaphragm, which forces steam with its entrained moisture out of the header into the separator body through the inlet port, the area of which is only slightly in excess of the pipe area, thus causing the steam and water to enter the receiver at a very high velocity.

In the vertical type, Fig. 11, the steam enters at the top and passes into the receiver chamber through the inlet port on the right. The inertia of the entrained moisture, due to its greater density, carries it to the bottom of the receiver out of the path of the steam, which circulates around the receiver and passes into the steam header again through the large outlet port shown on the left. Long baffle plates extend at an angle from each side of the continuous pipe, preventing any particles of moisture from being carried from inlet to outlet ports, or from creeping along the pipe.

In the horizontal type, Fig. 12, the steam enters at the left and passes down into the receiver through the inlet port, the entrainment being thereby carried to the bottom, while the steam, in order to pass into the header again, must circulate around in the receiver and rise to the outlet port in the top of the continuous pipe. Baffle plates similar to those in the vertical separator are provided along the sides of the header to prevent moisture from reaching the outlet port. The Elliott Co., Pittsburg, make a complete line of these separators, including angle types, etc., for pressures up to 250 lbs. per sq. in. They are made entirely of steel plates and piping with cast steel flanges screwed on

FIG. 12—HORIZONTAL "WELDERON" RECEIVER SEPARATOR WITH INTEGRAL PIPE AND DEFLECTING PLATES.

FIG. 13—"STRATTON" CENTRIFUGAL SEPARATOR SHOWING INTERCEPTING VANES IN RECEIVER AND CENTRAL OUTLET PIPE.

and welded. The receiver chamber is made in either riveted pipe which forms an integral part of the steam header is in all cases welded to the receiver chamber.

Stratton Steam Separator.

This device is illustrated in Fig. 13 and is designed and constructed to take advantage of the weight and velocity of the water in effecting separation. As shown in the sectional view, the water enters at the right hand side, traveling round behind the vertical outlet pipe, the helical passage causing it to strike the opposite wall at a slight angle, adhering to the wall and forming a thin sheet. This sheet of water flows forward and downward nearly to the bottom of the separator, where its circular motion is stopped by internal ribs, allowing it to collect in the bottom of the separator and flow into the drain pipe.

The current of steam, from which the

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(Trade Mark)

Vertical Engines

Admirably adapted to isolated installations because entirely enclosed, automatically lubricated, and requiring very little attention.

Compact—quiet in operation—and dependable in the highest degree.

Built in a wide range of sizes and with either forced feed lubrication or automatic gravity lubrication through sight feed glasses.

Described in Bulletin 218-E.

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Design and Material of Highest Class

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DIXON'S PIONEER BOILER GRAPHITE

is flake graphite. Flake Graphite is the "sapper" that undermines and penetrates the scale at the time of its formation.

Dixon's Pioneer Boiler Graphite attacks scale on all sides, rendering it easy to remove when a cleaning tool is used in the ordinary way.

One engineer effected a saving in cleaning cost of 28¾c on each boiler tube by using "Dixon's Pioneer" method.

Why don't you?

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Established 1827
Sole Canadian Agents
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Montreal, Que.

water first separates, continues its twisting motion downward to the lower end of the central vertical pipe which leads the steam to the outlet opening. This spinning action of the steam current keeps the sheet of separated water out

FIG. 14—VERTICAL "ELLIOTT" SEPARATOR WITH INVERTED VEE PLATE AND CONICAL FLANGES.

against the wall of the separator preventing it from returning inwards into the steam current after once leaving it.

The vanes in the receiver section of this separator are installed to arrest this rotation of the water so that proper drainage may take place. For convenience in connecting pipe lines, Stratton separators are made in both horizontal and vertical styles, with inlet and outlet openings arranged in any direction to suit conditions. For superheated steam and excessive pressures these separators are of cast steel construction throughout, three different classes being available with varying proportions of storage or receiver space to suit conditions. The Canadian Griscom-Russell

FIG. 15—HORIZONTAL "ELLIOTT" SEPARATOR SHOWING DEFLECTING PLATES AND ISOLATING GRID.

Co., Montreal, are the builders of this separator.

Elliott Steam Separators

This device employs the angular baffle principle with suitable deflection of the steam current. Vertical and horizontal types are shown in section in Figs. 14 and 15. In the former, steam enters at the top and strikes the slanting surfaces of the inverted "V" cast over the central outlet pipe. The openings to the outlet pipe are located beneath the inverted "V" but above the line of its lower edges. To reach these openings, the steam must pass under the edges of the "V" so that the entrained moisture being of greater density, is thrown from the path of the steam to the waste chamber at the bottom and thence to drain. Situated below the "V" are conical flanges which prevent the separated water from creeping up to the steam outlets.

The horizontal Elliott Separator, Fig. 15, is similar to the vertical in that the steam strikes the baffle at an angle instead of in a straight line, resulting in a minimum pressure drop in the separator with more complete separation. On entering at the left, a slanting baffle deflects the steam downward, this change of direction, together with the action of gravity, throwing the entrainment down to the water chamber. A set of inclined bars forms a grating which separates

FIG. 16—SECTIONAL VIEW OF "COCHRANE" SEPARATOR SHOWING SIDE POSTS AROUND BAFFLE PLATE.

the water from the steam chamber, isolating it in a complete manner from the steam current.

Another slanting baffle is placed in front of the outlet passage in such a manner that its upper edge is higher than the lower edge of the left-hand baffle, preventing any escape of entrainment. The designs shown are suited for 250 lbs. pressure, being made of semi-steel and reinforced by webs on neck and body. The Elliott Co., Pittsburgh, make these separators in sizes up to 12 in.

Cochrane Steam Separators

The horizontal type of this separator is illustrated in Figs. 16 and 17, the separating element being a single baffle plate facing the inlet opening, which presents a suitably proportioned surface for the impingement of all the particles of liquid traveling in the current, vertical ribs being provided to prevent side travel of the separated liquid. The baffle plate extends across the diameter of the head, with the exception of two ports having an area exceeding that of the entering pipe. An opening exists be-

tween the baffle plate and the edge of the inlet, so that large quantities of free liquid pour directly into the well. This well is entirely below the course of the current, the underside of the baffle plate being closed over to the outlet and provided with an internal drip pipe.

The ports are situated at the sides of the baffle plate and towards the top,

FIG. 17 — HORIZONTAL "COCHRANE" SEPARATOR WITH SPECIAL RECEIVER CHAMBER.

which, however, is closed for a suitable amount to insure the steam passing round the sides. The vertical form, not illustrated is modified in design and construction to meet the different direction of the current while retaining the same principles of separation. The Cochrane separator is made by the Harrison Safety Boiler Works, Philadelphia, Pa., in a large variety of designs suited to all locations and duties.

TRADE GOSSIP

Bothwell, Ont.—The Town Council are considering installing a waterworks system.

Swift Current, Sask.,—The City Council contemplate purchasing a 615 h. p. oil engine.

Winnipeg, Man.—The City Council will extend the Point du Bois power plant to 100,000 h.p., at a cost of $150,000.

Sudbury, Ont. — The Town Council proposes to spend $7,000 on extensions to its power plant. W. J. Ross is clerk.

Amherst, N.S.—The Maritime Coal, Railway & Power Co., contemplate purchasing pumps, motors and electrical equipment.

Hull, Que.—The city council will call tenders about May 1, for a mechanical filtration plant to cost $170,000. J. P. A. Laforest is engineer.

Chignecto, N.S.—The Maritime Coal, Railway & Power Co., proposes to purchase electric pumps, motors, etc., for to plant. R. J. Bell is general manager.

Coaticook, Que.—Penman's Ltd., propose to erect a power house, construct a concrete dam, and install 180 h.p. turbine and generator. Engineers, T. Pringle & Sons, Ltd., Montreal.

CATALOGUES

Galt Sprinkler Stoker.—The Galt Foundry Co., Galt, Ont., have issued an attractive catalogue dealing with the economic and smokeless burning of coal, including lignite, and at the same time featuring the Galt sprinkler stoker. A full description is given of this type of stoker, and its principal features dealt with in detail, accompanied by numerous illustrations showing the construction and application to various types of boiler. The concluding pages contain some useful engineering data covering evaporation formulae, heat values of coal, feed water calculations, miscellaneous tables, etc. The catalogue also contains instructions for reading the slide rule, accompanied by diagrams. The McNaughton rocking sectional grate bar is also described and illustrated. The catalogue is well gotten up, being printed on coated paper, with exceptionally clear half-tones.

CLASSIFIED ADVERTISING

WANTED—A GOOD SALES ENGINEER to open office to sell Moline heat in Canadian territory. Must be a good salesman, having had a general heating and ventilating experience. Must give good references. We have a fine proposition for the right man. Address Moline Heat, Moline, Ill. ctfm

WANTED — EXPERIENCED GAS ENGINeer; some knowledge of electrical work; must be first-class engineer. Reply, stating experience and wages. Box 273, The Power House. (2)

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A trial will convince you. Write for Catalog

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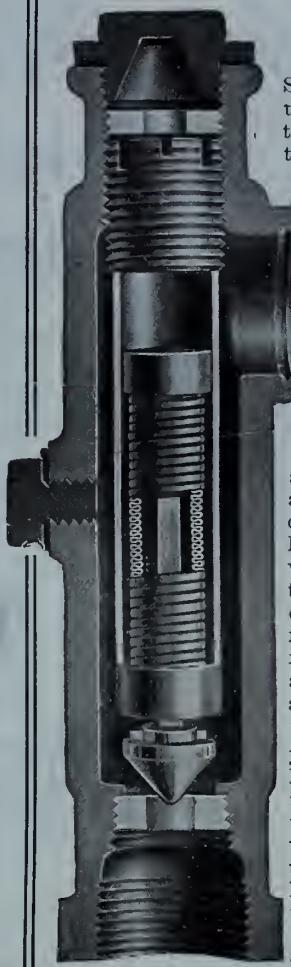
The Steam Trap Sarco Works Hydraulically



Some steam traps of the thermostatic type are operated by ethyl alcohol or other volatile liquids which vaporize. Other traps open and close when a float rises and falls or when a bucket fills and empties.

Work out for yourself how little power traps of this type can develop unless of unusual size. Figure, too, what power is needed to close off quickly and certainly against 100 lbs. steam pressure or 50 or 20 lbs.

Traps of this kind either choke the line and never open freely to discharge but just dribble it through like a cracked valve, or if they open, drain the water, and then, pass a rush of steam before they are able to close against the pressure. **That is where your wasted steam goes.**

The Sarco is quite different. It is hydraulic power which opens and closes the trap. The expansion element is a fluid which at the temperature of the condensation occupies a certain amount of space and at the steam temperature occupies much more space. The difference represents hydraulic power sufficient to close the trap absolutely and unfailingly against any steam pressure up to 200 lbs. You don't waste steam with the Sarco; it can't get past.

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Write for Bulletin J—4.

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"Boiler Scale Troubles have ended"

This is the proof of the efficiency of

"Imperial" Boiler Coating

that is reaching us by every mail. Imperial Boiler Coating has never failed to remove scale where it has been given fair trial — and because of this we are willing to send you a sufficient quantity to satisfactorily treat your boiler against scale formation on the fair basis of **"satisfaction or no pay."**

Imperial Boiler Coating is not a compound and there are positively no acids, graphite or other harmful ingredients in it.

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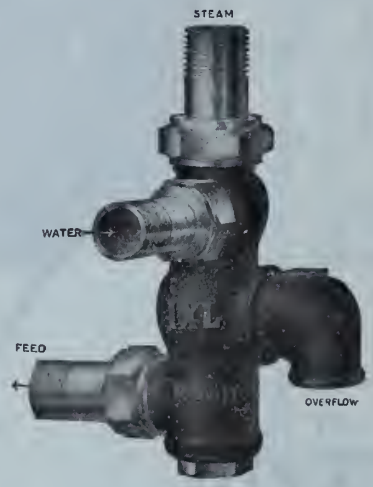
AUTOMATIC RE-STARTING
INJECTOR



The Best and Most Economical Automatic Injector on the Market

These "IXL" Injectors have increased areas where cones fit in body, enabling them to do more work and give better satisfaction than any other automatic single tube Injector.

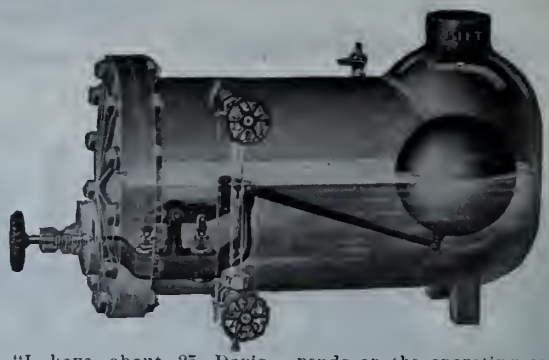
EVERY INJECTOR TESTED.

Price List upon Application.

T. McAVITY & SONS
LIMITED

St. John, N.B., Canada

Montreal Winnipeg



"I have about 25 Davis Traps of various sizes in service, the majority of them for 22 years. I will gladly recommend them at all times," wrote H. F. Hustedt, Chief Engineer, Tulane University, New Orleans, when ordering his first repairs.

Possibly all Davis Traps would not last that long without repairs. Much depends on the operating conditions. On some installations they last longer than on others. But all Davis Traps have Tobin Bronze seats and valves—a hard, tough metal from which long service may be expected.

And when these vital parts of the trap do wear out, they may be easily renewed at slight expense.

We make Pressure Regulators . Balanced Valve . Float Valve . Steam Trap . Back Pressure Valve . Exhaust Relief Valves . Stop and Check Valves . Pump Governors . Damper Regulators . Radiator Air Valves . . Emergency Stop Valves.

G. M. Davis Regulator Co.
434 Milwaukee Avenue, Chicago., Ill.

New York, 123 Liberty—Boston, 70 High—Philadelphia, 260 N. 11th—The Renshaw Bldg., in Pittsburgh—Calvert in Baltimore, and Rialto in San Francisco.

Valve Specialty Manufacturers Since 1875

You, Mr. Engineer

can greatly reduce your firm's fuse expense—in fact you can cut it down 80 per cent. by using

"ECONOMY"
Renewable Cartridge Fuses

They are no experiments—millions of them are in use.

Made in Canada and sanctioned by the Canadian Fire Underwriters' Association

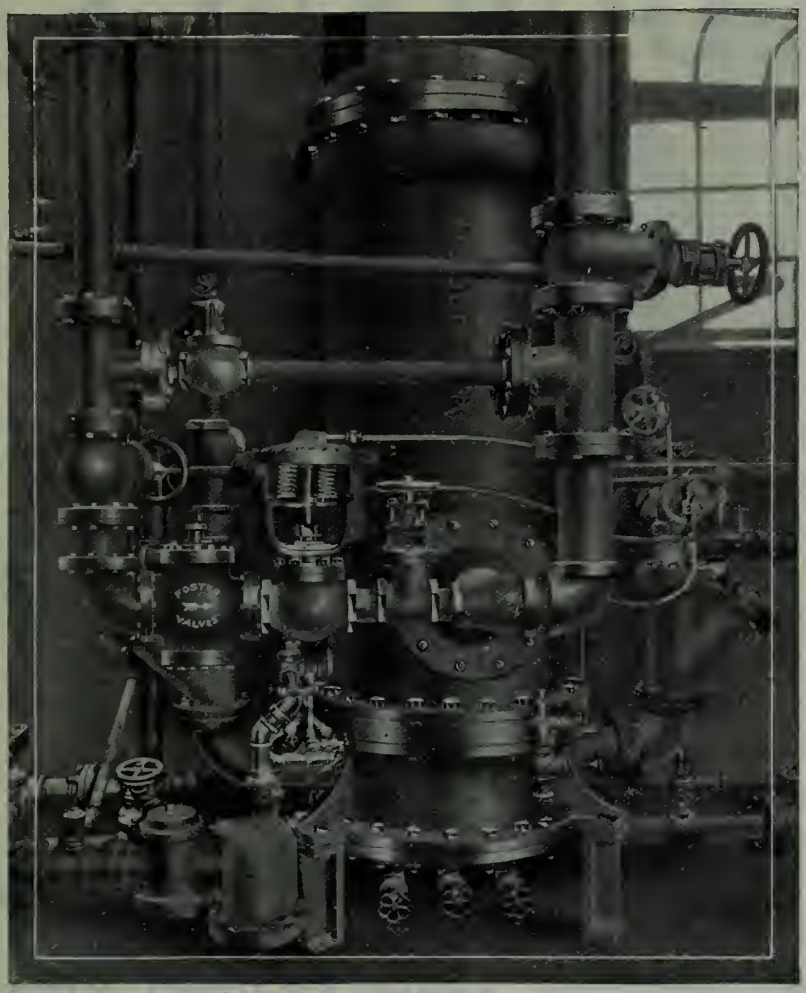
Free samples of any desired types and capacities sent with Catalogue No. 24. List of prominent users included

ECONOMY FUSE & MFG. CO. OF CANADA, LIMITED
UNITY BUILDING - MONTREAL

Manufacturers in Canada of "S. & C." High Potential Fuses,—to 150,000 Volts.

15,000 U.S. Gallon Alberger Multi-Head Service Heater.

Live and Exhaust Steam



in the Royal Victoria Hospital, Montreal, P.Q., Supplies Hot Water for Laundry.

Foster Reducing Valve Reduces Live Steam

Highest possible degree of heat transmission. Minimum cost of operation, and an insignificant—if any—cost of maintenance.

THIS IS THE IDEA UPON WHICH EVERY ALBERGER MULTI-HEAD HEATER IS BUILT, AND THE RESULTS SHOW IT.

These heaters are of the water tube type: i.e., the water passes through the tubes which are surrounded by steam

The Alberger Multi-Head heater stands alone in its freedom from tube troubles. With our series of "floating" tube heads, the several groups of tubes can expand or contract entirely independent of each other, thereby accommodating the expansion. With this construction, dangerous strains on the tubes and tube heads are eliminated.

THE FOLLOWING ARE A FEW OF THE USES TO WHICH THE ALBERGER MULTI-HEAD HEATER HAS BEEN SUCCESSFULLY APPLIED: Feed Water Heaters, Condensers, Water and Air Coolers, Domestic Water Heaters, Laundry Heaters, Forced Circulation, Hot Water Heaters, Wort Coolers, etc., etc.

It is a heater that you should investigate, because its service and economy "goes 'em one better." IT HEATS INSTANTANEOUSLY.

WRITE FOR DETAILED INFORMATION.

The Canadian Fairbanks-Morse Company, Limited

Canada's Departmental House for Mechanical Goods.

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

If any advertisement interests you, tear it out now and place with letters to be answered.

SPECIFY DURABLA PACKING

DURABLA
TRADE MARK

DURABLA
TRADE MARK

Note the Durabla Trade-Mark all over the sheet. A Guarantee of Quality.

Durabla is a Long Fibred Asbestos Sheet sold on Service Basis and guaranteed to make a Tight Joint.

It is the Bond that is the most important part of an Asbestos Sheet.

Only when you combine the right Binding materials with High Grade Long Fibred Asbestos do you secure a perfect Asbestos Sheet Packing.

Therein lies the Secret of the wearing Quality of Durabla, the Packing that will keep any joint tight, and stand everything that the Flanges will stand.

Durabla does not crack or dry out. It can be rolled and unrolled and will not deteriorate in stock.

On saturated and superheated steam, High and Low Pressures, Air, Gas, Oil and Ammonia, Durabla will keep your Flanges tight and give you Lasting Service.

DURABLA MANUFACTURING COMPANY

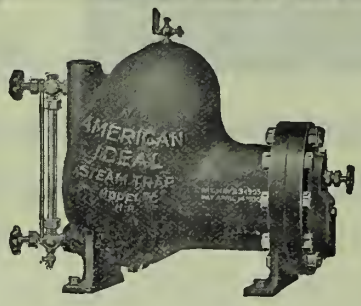
New York

Canadian Distributors:
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Toronto Montreal Winnipeg Calgary Vancouver Windsor St. John Victoria Ottawa

SERVICE COUNTS

AMERICAN IDEAL STEAM TRAPS



were selected for the High Pressure Service in the MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Why not begin checking up your inefficient traps and BEGIN INSTALLING AMERICAN IDEAL TRAPS NOW.

Unequalled for HIGH or LOW pressure service.

Write for Catechism Booklet.

Sole Agents for Canada: CANADIAN FAIRBANKS-MORS CO., LTD., Montreal, Toronto, Winnipeg, Calgary, St. Joh

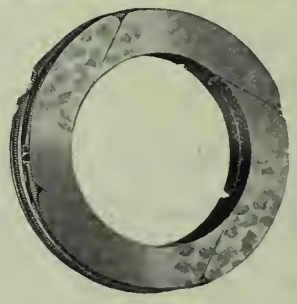
CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

AMERICAN STEAM GAUGE & VALVE MFG. COMPANY

New York Chicago BOSTON Atlanta Pittsburgh

MARTELL PACKINGS MEAN MORE POWER



FAILURE IMPOSSIBLE

Martell packings are in big demand. The call for these superior packings increases day by day, because they never fail. There is little or no friction upon the rod with Martell Packings and no clearance for wear adjustments need be left between the ends. **Sudden failure with the Martell type of packing is unheard of.** It is the ideal packing.

Cut at a tangent to piston rod, and joints on diametrically opposite sides of piston are parallel. This arrangement of the joints of the ring allows the parts to adjust themselves to slight inequality of wear in the diameter of the rod, as they float freely. Therein lies superiority of Martell packings.

It will pay you to try them.

Give Martell Packings a Trial.

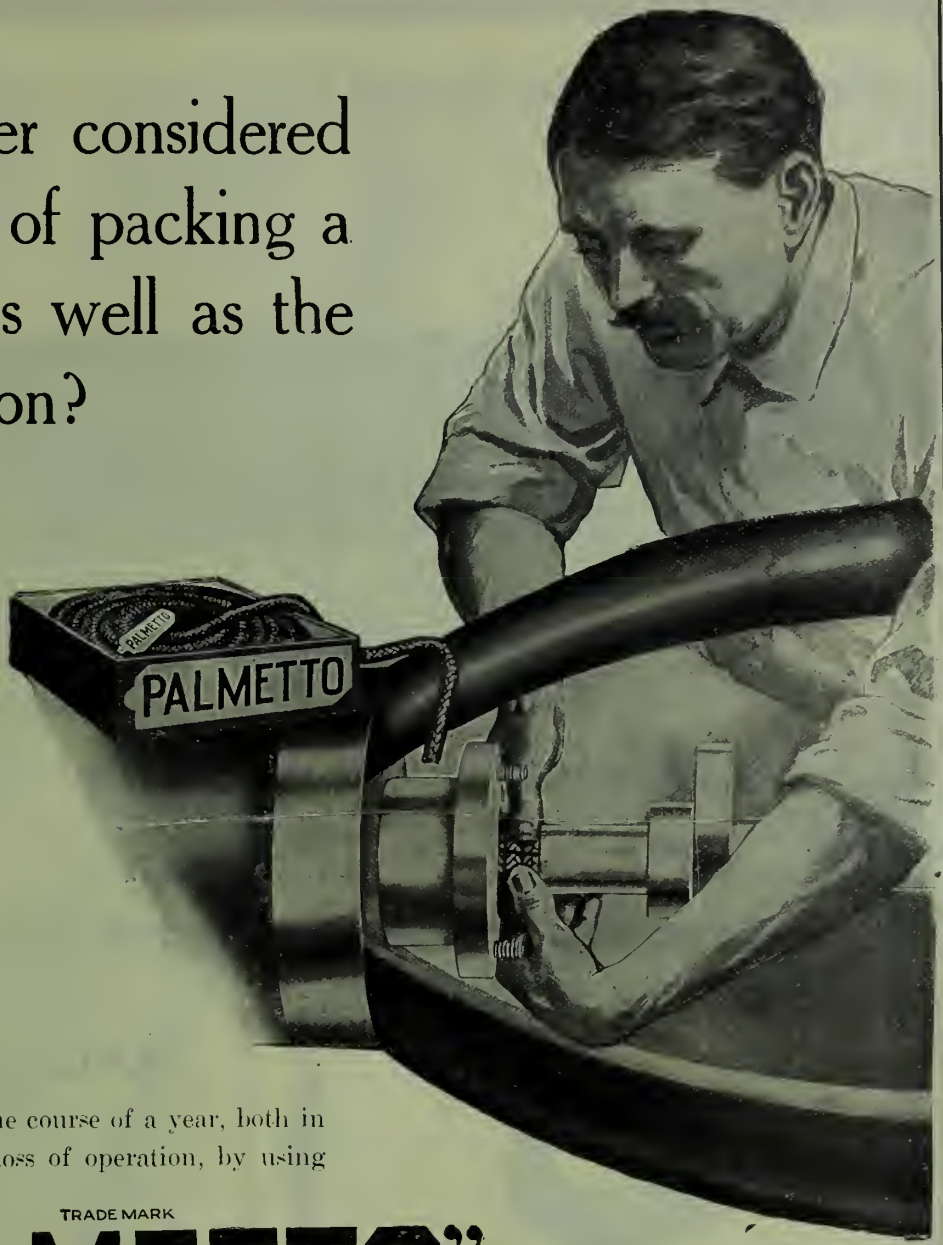
CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

The Martell Packings Company, Inc., Elyria, Ohio

Canadian Agents: THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Have you ever considered the labor cost of packing a stuffing box, as well as the loss of operation?



It's a startling amount, especially if you use those packings that have no great lasting qualities and only a low first cost to recommend them.

A great deal can be saved in the course of a year, both in labor cost of application and loss of operation, by using

TRADE MARK

"PALMETTO" PACKING

because it gives a length of service unknown to other packings, due entirely to the grade of materials used and a special process of lubricating each single strand before braiding or twisting. This greater thoroughness costs money, but it pays in the longer life of service.

Let us send you sample of both braided and twist to test under your own conditions. No charge.

GREENE, TWEED & CO., ***Sole Manufacturers***

109 Duane Street, New York

Representatives in Canada:

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

St. John Toronto Quebec Hamilton Montreal Ottawa Vancouver Victoria

The ALBERGER Multi-Head Heater

Stands alone in its freedom from Tube Troubles

The double floating head construction eliminates the dangers of expansion strains to which other heaters are subjected.

COPPER Tubes, Corrugated, eliminate the segregation of materials and splitting, so common with brass tubes.

The helical spiral corrugation gives the water a whirl, which keeps the tubes clean and free from scale, INCREASES HEAT UNITS BY 50% OVER THE STRAIGHT TUBES SO COMMONLY USED.

The Alberger Multi-Head Heater is built on practical lines, which can only be perfected by years of experience.

Write to-day for Bulletin 201.

ALBERGER HEATER COMPANY, BUFFALO, N.Y.

GENERAL SALES AGENTS:

CANADIAN FAIRBANKS-MORSE COMPANY, Limited

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CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

Bakelite Discs

Jenkins' Type

The wonderful success of Bakelite Discs in thousands of Fairbanks' Valves has led to the production of a full range of Jenkins' Type Bakelite Discs.

These Discs are ready for immediate delivery.

Specify "Bakelite" Discs on your next order for Jenkins' Type Discs, and reduce your Disc Costs.

PLASTICS LIMITED, Toronto

Sole Sales Agents:

The Canadian Fairbanks-Morse Company, Limited

CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

BOILER ACCESSORIES

By Walter S. Leland, S. B.

Formerly Assistant Professor of Naval Architecture, Mass. Institute of Technology, American Society Naval Architects and Marine Engineers. 144 pp., 72 illus. Cloth binding. A treatise giving complete descriptions of the various accessories of the boiler room and engine room essential to economical operation, such as evaporators, pumps, feed-water heaters, injectors, mechanical stokers, etc., with practical instruction in their use. Price $1.00

STEAM TURBINES

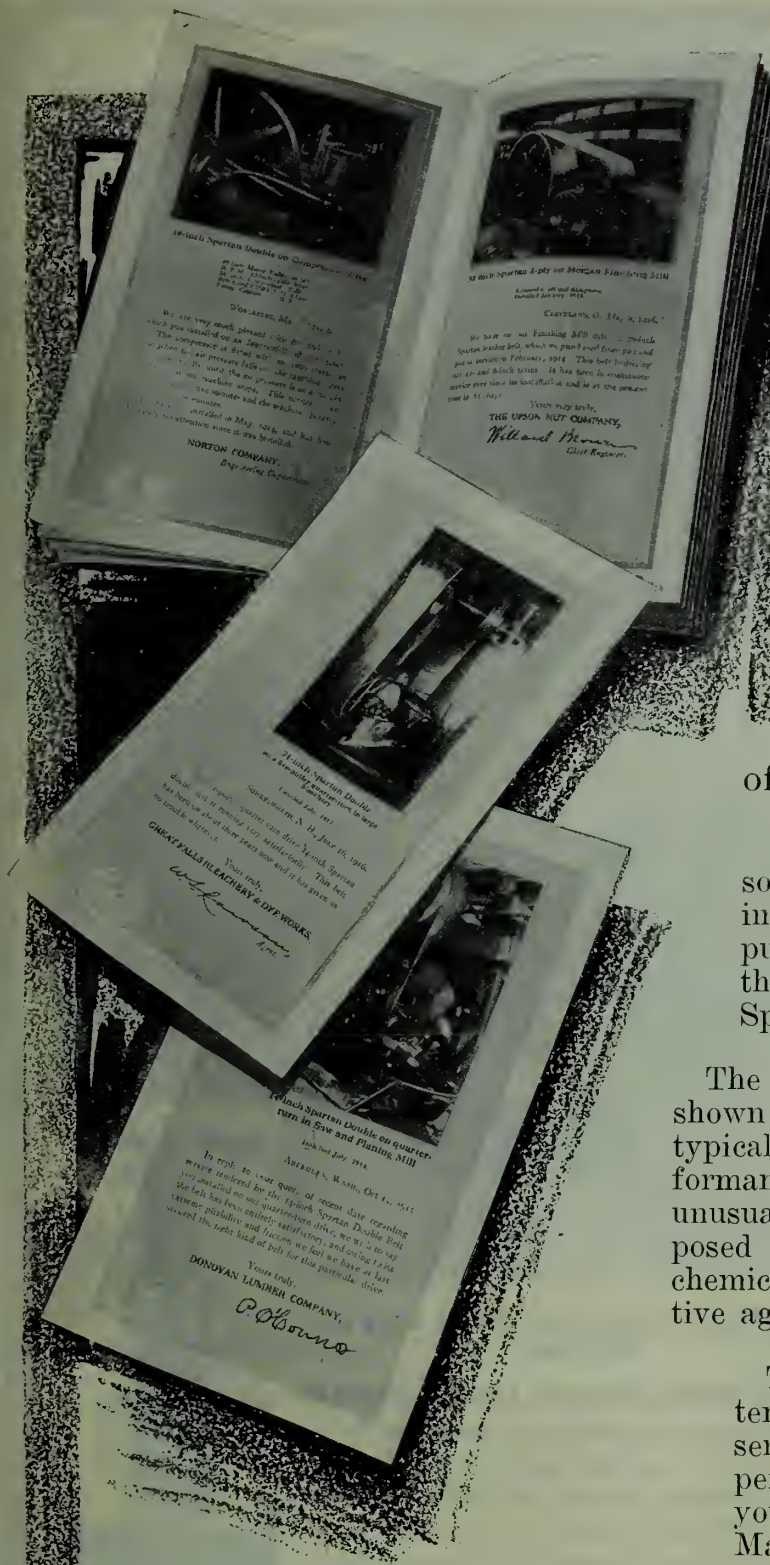
By Walter S. Leland, S. B.

Assistant Professor of Naval Architecture, Massachusetts Institute of Technology, American Society of Naval Architects and Marine Engineers. 160 pp. 100 illus. Cloth binding. A reliable and up-to-date manual on the selection, construction, and operation of steam turbines, including the installation, performance and types of turbines; single-stage and compound turbines, such as De Laval, Riedler-Stumpf, Rateau, Hamilton-Holswarth, Terry, Parsons, Allis-Chalmers, etc., with a discussion of the use of low-pressure steam turbines with steam engines. Price $1.00

Write TECHNICAL BOOK DEPARTMENT

THE MACLEAN PUBLISHING COMPANY

143-153 University Avenue TORONTO



27 Hard Drives

The solution of the hard-drive problems in every plant depends largely upon the use of proper belting equipment.

Spartan Leather Belting has solved these hard-drive problems in so many plants that we have published a booklet—a record of the experience of others with Spartan Belting.

The twenty-seven hard drives shown in the Spartan Booklet are typical illustrations of the daily performance of Spartan Belting under unusually severe conditions — exposed to water, steam, oil, heat, chemical fumes, and other destructive agencies.

The Spartan Book will interest you, and we want to send a copy because it is pertinent to the solution of your hard-drive problems. May we send it?

THE GRATON & KNIGHT MANUFACTURING COMPANY

Leather Tanners and Belt Makers

WORCESTER, MASS. U.S.A.

1851 G&K TRADE MARK

Selling Agents: The Canadian Fairbanks-Morse Co., Limited, St. John, Toronto, Quebec, Hamilton, Montreal, Ottawa, Vancouver, Victoria

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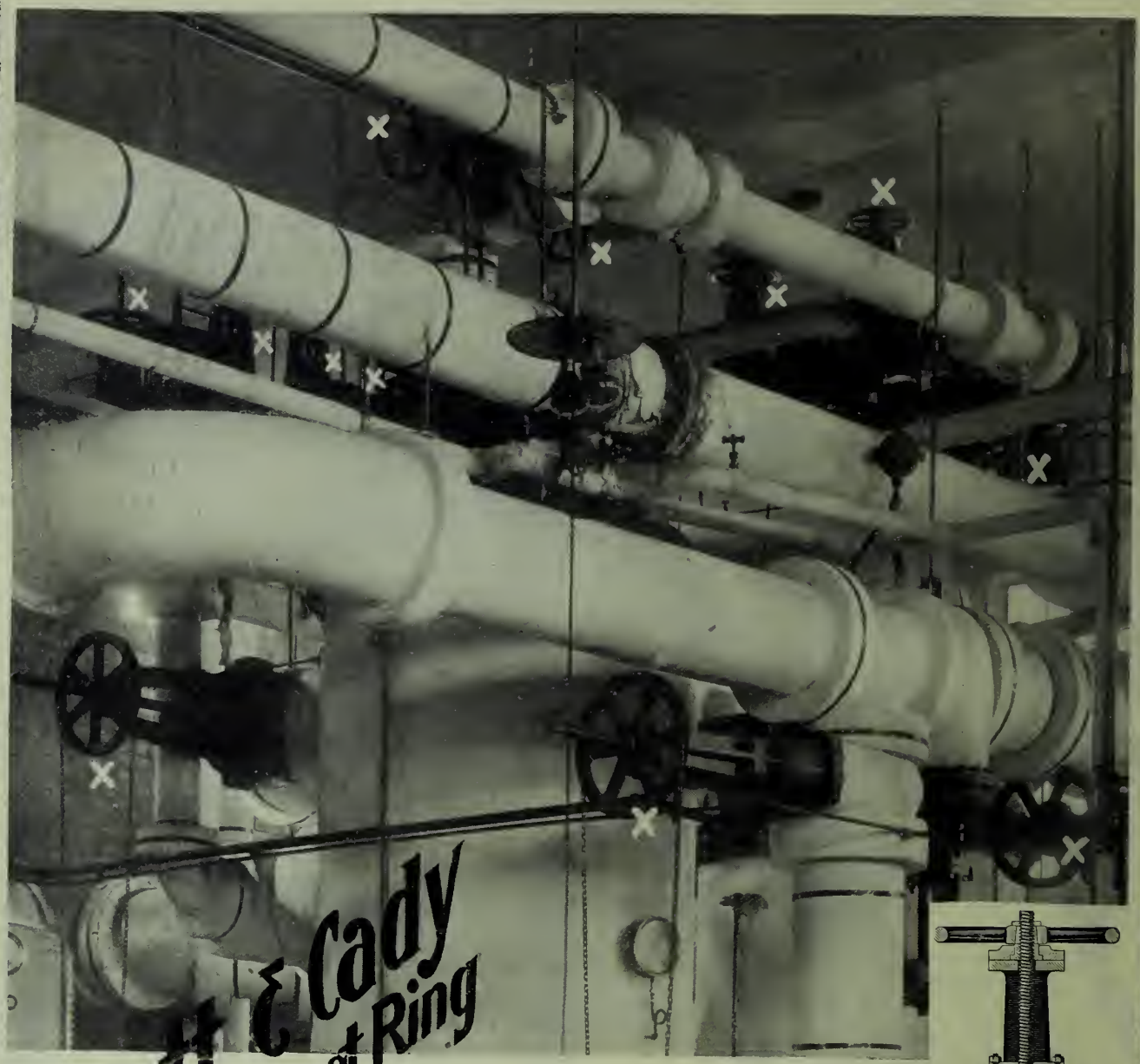
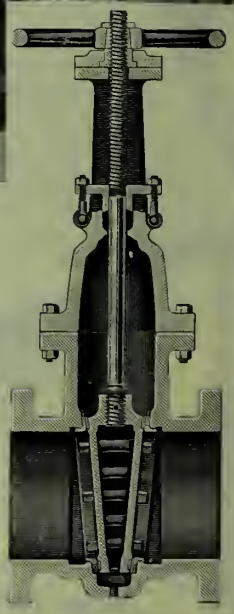


Pratt & Cady Renewable Seat Ring VALVES



1" to 14" (on Steam Line, Water Line and By-pass)

Heating System, Toronto General Hospital

2 heaters of 1500 and 1000 sq. ft. surface each.

CHIEF ENGINEER, MR. GIBSON, STATES, "THESE VALVES HAVE GIVEN EXCELLENT SATISFACTION SINCE INSTALLATION."

Pratt & Cady valves always satisfy.
For the past forty years the most progressive engineers in this country have conceded their superiority.
Pratt & Cady valves are easily operated, take pressure from either side, and will not wedge. Seat Rings are easily renewable without removing the valves from the pipe line.
These valves are made for every service in many patterns and weights.
Ask for our catalog.

Manufactured by Pratt & Cady, INC., Hartford, Conn.

CANADIAN SALES AGENTS:

The Canadian Fairbanks-Morse Company, Limited

St. John Quebec Montreal Ottawa Toronto Hamilton
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

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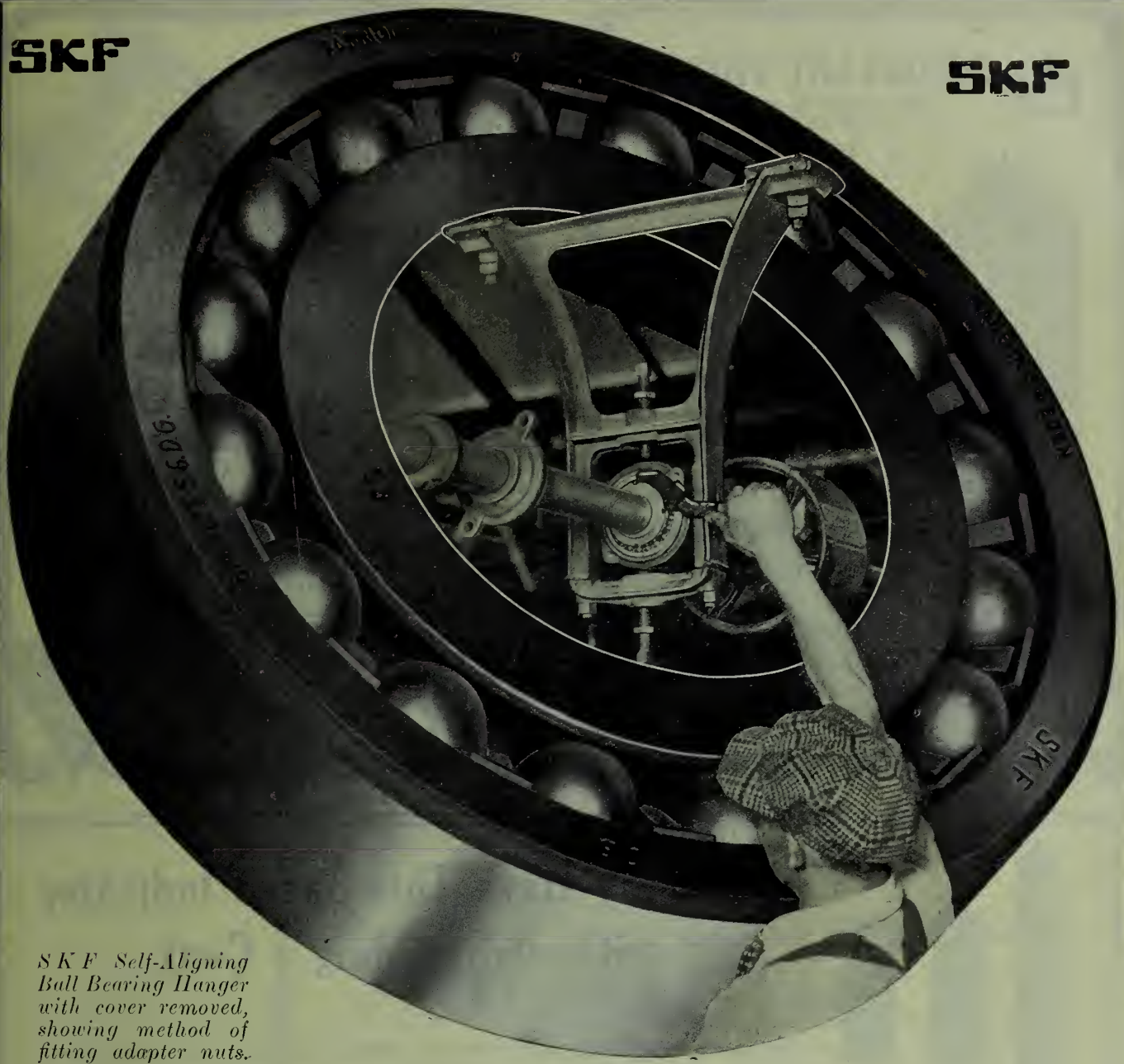
CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS



S K F Self-Aligning Ball Bearing Hanger with cover removed, showing method of fitting adapter nuts.

USE IT—DON'T WASTE POWER

It doesn't pay to use the old style, profit-eating, plain bearing hangers, when newer, self-aligning, ball-bearing hangers will save from 15 to 24% of the cost of power for operating your line shafting.

What you save in power, not the cost to install, should be the basis for buying all equipment. S K F Self-Aligning Ball-Bearing Hangers insure a saving in power, in lubrication, in maintenance and equipment.

Binding strains, due to out-of-true shafting, are the cause of most of the hot boxes in plain bearing hangers. S K F Self-Aligning Ball-Bearing Hangers automatically adapt themselves to any shaft deflection or spring. No binding strains, no wear, no hot bearings.

Write for our literature giving further information. Complete evidence on request.

CANADIAN SKF COMPANY

TORONTO **LIMITED** **CANADA**

SOLE CANADIAN AGENTS: THE CANADIAN FAIRBANKS-MORSE COMPANY, Limited

St. John Montreal Quebec Toronto Hamilton Windsor Winnipeg Saskatoon Calgary Edmonton Vancouver Victora

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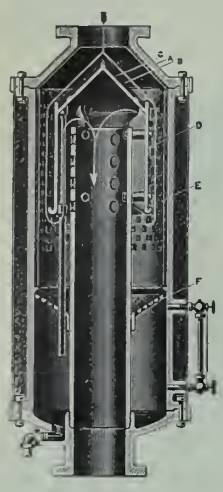
III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
820 Geddes Street - SYRACUSE, N.Y.

General Sales Agents:
Canadian Fairbanks-Morse Co., Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Vancouver, Victoria.

CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.
Philadelphia, Pa.

Canadian Agents:
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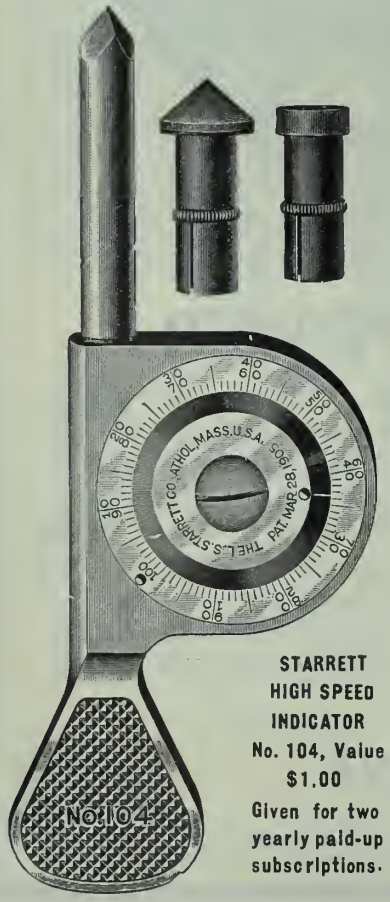


STARRETT HIGH SPEED INDICATOR
No. 104, Value $1.00
Given for two yearly paid-up subscriptions.

You May Have This Speed Indicator without Spending a Cent

if you are a subscriber to "THE POWER HOUSE." If you are not a subscriber, send in your own subscription together with two others, and the indicator you are entitled to will be mailed to you immediately.

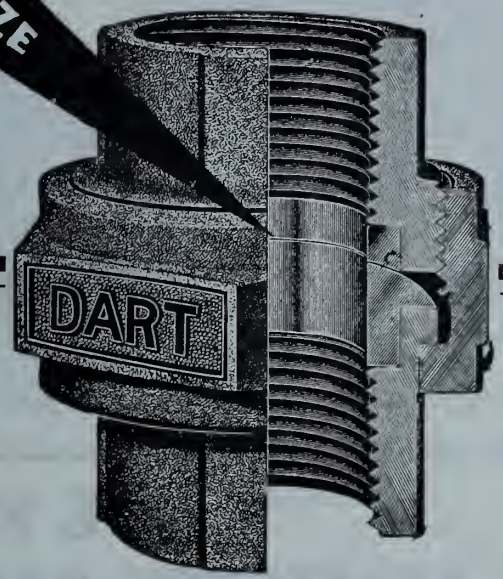
To subscribers who send us two NEW yearly paid-up subscriptions we will send this $1.00 indicator.

"THE POWER HOUSE" is designed to give Canadian Engineers, Superintendents and Power Users all the latest and best information in the engineering field. A little work among your engineer friends and acquaintances will earn for you this handy indicator without any trouble. Try it and see how easy it will be.

PUBLISHED MONTHLY AT $1.00 PER YEAR
Start in TO-DAY to earn one of these Handy Tools

THE POWER HOUSE 143 University Ave., **Toronto**

BRONZE TO BRONZE
at the Joint



Pipe Joints Never Loosen Up and Leak

When **Dart Unions** are Used

Dart Unions never deteriorate at the joint because both faces are of non-corroding metal.

The Heavy Iron Parts make stretching or pulling apart impossible.

The Ball-shaped Joint makes connecting easy, whether pipes are in or out of alignment. A connection that's made with a Dart Union requires no attention, and is insurance against damage by leaks and accidents by blow-outs.

The use of the Dart is real economy.

Sold by all jobbers.

Dart Union Company, Limited
TORONTO, CANADA

If any advertisement interests you, tear it out now and place with letters to be answered.

LUNKENHEIMER
"Victor" Gate Valves

predominate the gate valve field. Their sturdy construction incorporating the "solid wedge" type of disc, together with high quality materials and workmanship, is the embodiment of "the best" in gate vales.

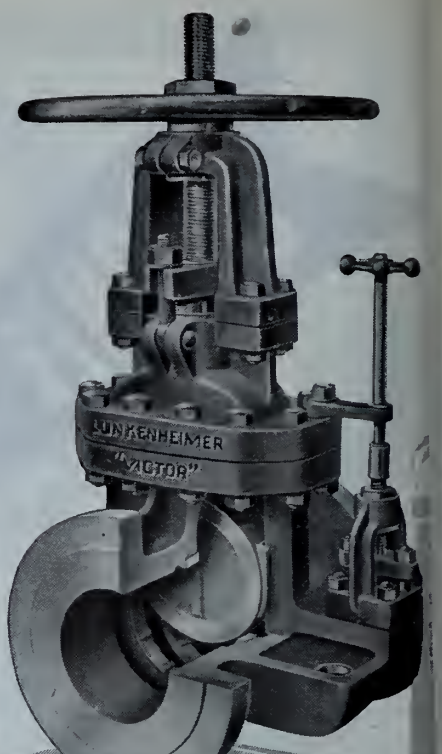
The high efficiency and low maintenance cost of the "Victor" are contributing factors to power plant economy, hence their universal use in this field.

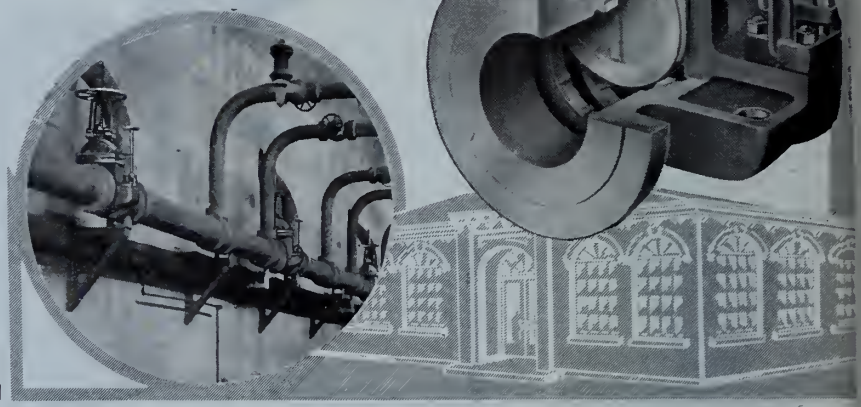
The complete line, embracing valves made of Bronze, Cast Iron, "Puddled" Semi-steel and Cast Steel, in all standard sizes and for pressures ranging up to 350 pounds and temperatures to 800° F., provides a type suitable for every power plant need.

Specify **Lunkenheimer "Victor"** — and insist on getting the genuine.

Your local dealer can furnish them; if not, write us.

Write for descriptive literature.





THE LUNKENHEIMER CO.
"QUALITY"
Largest Manufacturers of High-Grade Engineering Specialties in the World
Cincinnati, O., U.S.A.
New York Chicago Boston London
6-12-43

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

GARLOCK
NINE HUNDRED SHEET

Is unsurpassed for superheated steam joints,
It is equally well adapted to air, acids, ammonia,
Or any severe condition where sheet packing is required.
It is made of the highest quality of long fibre asbestos,
And is built up into sheet form under tremendous pressure,
Thus securing great toughness, flexibility and tensile strength.
It is not affected by extremely high pressures and temperatures,
And does not require following up after gaskets have been applied.
Joints can be opened as often as desired without injury to gaskets.
This sheet is furnished in all thicknesses from 1-64 to ¼ inch.
Gaskets of all shapes and sizes can be cut by us from Nine Hundred Sheet.

The Garlock Packing Company, Hamilton, Ontario

BRANCHES:

Montreal, Quebec - - -	409 Shaughnessy Bldg.
Toronto, Ontario - -	404 Continental Life Building
Winnipeg, Manitoba - - - - -	Galt Building

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D. K. McLaren's

Genuine British Oak Tanned

LEATHER BELTING

"Only flawless back leather is used and our genuine British Oak Tanning Process preserves every bit of the hide's natural strength.

Every inch of our belting is reliable, while our prices are the lowest—quality considered."

Grip that will give you more revolutions per minute

The use of this belting reduces slip to a minimum, thereby saving a considerable amount of power. It also saves a remarkable amount of time, labor and attention, because there is practically no stretch.

The toughness and durability of D. K. McLaren's belting makes lasting qualities that are surprising.

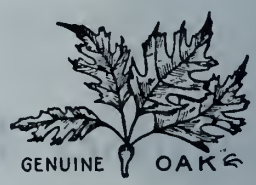
Many of Canada's largest industrial plants (firms that want the best of everything) are our steady customers.

Once tried, always used.

D·K·McLAREN LIMITED

Head Office and Factory: 351 St. James St., Montreal, P.Q.

TORONTO, ONT.	ST. JOHN, N.B.	VANCOUVER, B.C.
194 King St. West	64 Prince William St.	847 Beatty St.



This Quality Guarantee appears on every piece.

ECONOMY **UNIFORMITY**

AMACOL
TENAXAS
TIN TOUGHENED
ATLAS
MASCOT
W.E.W. BABBITT

THIS RANGE OF
ATLAS BABBITTS
WILL MEET ANY OF
YOUR DEMANDS
AND **SATISFY** YOU

ATLAS METAL and ALLOYS COMPANY of CANADA, Limited
MONTREAL

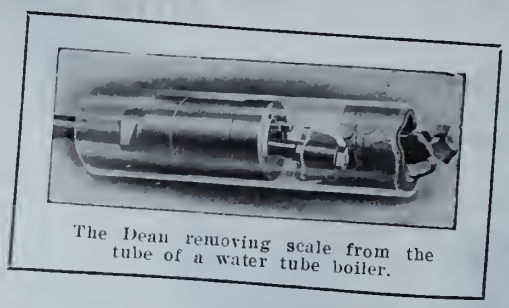
Sales Agents:

The Canadian B. K. Morton Co., Limited

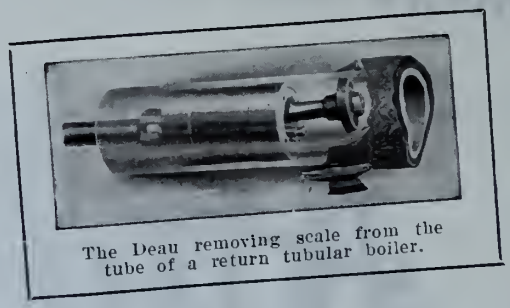
MONTREAL
49 Common Street

TORONTO
86 Richmond Street, East

Your Boiler Tubes MUST Be Kept Clean



The Dean removing scale from the tube of a water tube boiler.



The Deau removing scale from the tube of a return tubular boiler.

You cannot afford to adopt halfway methods in ridding your boilers from scale. The tube cleaner that is not removing every bit of the scale is worse than useless because it lulls the engineer into a feeling of false security.

If even a small percentage of the scale is allowed to remain on the tubes, they will become overheated, burn out in spots and put your entire plant in constant danger of a sudden explosion, or serious tube failure.

In competitive tests, the **Dean Boiler Tube Cleaner** has repeatedly demonstrated its superiority as a THOROUGH remover of scale against every method and device made. In many cases, where other cleaners have been put to a severe strain to clean out a small quantity of scale, the **Dean**, operated through the **same tubes** immediately thereafter, has taken out large additional quantities.

Thus, the **Dean** is the final test whereby the results of all other scale-removing methods must be judged.

Why not get a **Dean** first, and be sure of COMPLETE scale elimination?

You may be **absolutely positive** you have no scale, or that your present cleaner is satisfactory. So were many enthusiastic Dean users before they tried this tool.

Try the **Dean** at our expense, and give it a fair chance to show you what you have been missing without it. An agreement to give the Dean a trial implies no obligatiou to purchase. Write to-day for details of free trial offer.

Dean

The William B. Pierce Co.

Dean

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153 Ellicott St., Buffalo, N.Y. — W. W. Hicks, 567 Banning St., Winnipeg — 201-2 Coristine Bldg., Montreal, P.Q.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have beeu approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should sucb repairs be considered extensive by tbe Cbief Boiler Inspector, the boilers will require to be inspected.

In eacb and every case the inspections must be made by Inspectors authorized to inspect boilers under tbe Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all higb pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways.

W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

Morehead
Back to Boiler
SYSTEM

60,000,000 Tons of Coal Thrown Away Yearly

Over 600,000,000 tons of coal are mined yearly in the United States and Canada. Ten per cent. of that enormous production is carelessly, needlessly wasted. Over Sixty Millions of Dollars are spent each year in producing—nothing, and yet, a mere fraction of that great loss, if properly applied, would save those wasted millions for years to come.

You are contributing to this national waste—but you can stop it.

Steam, after its expansive energy is exhausted, is not through with its job. There are heat units left—live, tangible heat units which were purchased by coal at tbe boiler's mouth.

What Are You Doing With These Heat Units?

This condensation, in other words.

With the Morehead System installed on your steam lines the condensatiou is automatically returned to the boiler—without pumps—and at any temperature. It is the last link from boiler back to boiler—the unused energy is not wasted.

If you would save this ten per cent. and have a clear steam system which drains automatically, write to-day for particulars.

CANADIAN MOREHEAD MFG. CO.
WOODSTOCK, ONTARIO

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of paying for themselves in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps an adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

CANADIAN Sirocco COMPANY LIMITED

WINDSOR. ONTARIO.

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A system for every requirement.

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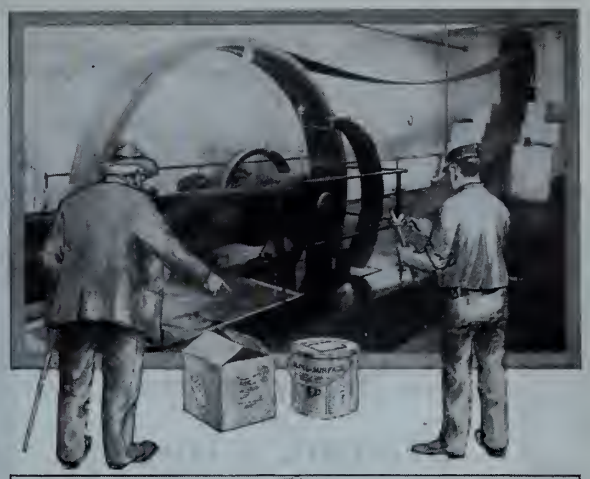
Representatives Everywhere



"CLING-SURFACE! Why, I heard of that twenty years ago! Never took much stock in it, George"
"Well, Uncle, I couldn't get along without it"

Back in '96 and '97, when "Uncle" ran an engine, people took more for granted.

For instance: power lost between engine and machines. With shafting true and bearings oiled, they still lost a lot of power because the belts slipped.

Their belts were run tight. When stretched they were taken up again. This caused friction, which ate up coal and kept the shop busy filling oil cups and cooling hot bearings. So between slipping belts and this friction, 5 to 30 per cent. of the power was lost.

Yet no belt, unaided, could run under full load **without** slipping. If the belts were heavy enough, and the pulleys large enough, a good deal of slip was avoided, but larger equipment required more power to move it.

And sticky belt dressings were as harmful then as to-day. They stopped belt slip for a time, but gummed up both belt and pulley faces; they tore the belts and, often containing rosin or other injurious materials, eventually destroyed them.

It was about this time CLING-SURFACE was discovered. A small beginning: its name did not stare at you in the papers.

Yet CLING-SURFACE soon became well known. People heard of it because it accomplished things.

For tension was doing by *main force* what could better be done by *"persuasion."* And the men behind CLING-SURFACE had found this better way.

CLING-SURFACE stopped the slipping. Since this was the one prime cause for tension, with slipping already stopped, why use it at all?

The Cling-Surface Company preached *slack* belts. Manufacturers who tried CLING-SURFACE discovered a great saving. *No take-up was necessary*, there was no slipping, belts lasted longer, and more power was delivered to the machines with less oil, coal, time and money required than when the belts were run tight.

CLING-SURFACE has grown for twenty years because it has kept on accomplishing things. And it will do the same for you.

We have many interesting booklets: one may describe your conditions. Let us send it to you—with the plan 10,000 firms have found successful. All free.

Remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface the belt preserver for belts TRADE MARK

Cling-Surface Co

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SteamCylinder

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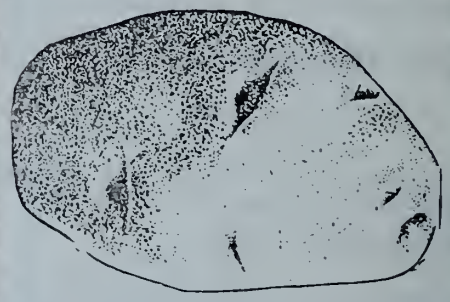
OILS

These Lubricants give remarkable service. They will keep your machinery running smoothly, easily and with a minimum of wear and cost.

No better time than now to put them to the test. The prices are very reasonable.

Potato Scale Powder Boiler Cleanser



Will positively rid your boilers of old scale and will *keep* tubes clean if but a small amount is fed daily through the feed water.

Eliminates foaming, pitting or any other boiler troubles due to impurities in the water supply. *Makes big reduction in fuel bills.*

Sold UNDER A POSITIVE GUARANTEE. Try a Barrel.

C. C. SNOWDON

Oils Refiner, Manufacturer and Importer, Pennsylvania, Lubricating and Refined Oils, Gasoline, Potato Scale Powder, Liquid Soap, Disinfectants, Polish, Waste. Oil Tanks, etc.

Winnipeg—Cor. Notre Dame and Pine Sts., P.O. Box 1984.
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Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

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THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

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Improved Bearings

Are all the bearings in your plant running cool and easy? Are they bound up by friction, consuming wastefully power that should be used in useful work? If so improve this condition by using Albany Grease on every bearing in your plant—always. Albany Grease is efficient and at the same time very economical. It keeps bearings running cool and eliminates friction and can be used in any kind of grease cup. Send for a trial quantity of Albany Grease and an Albany Cup—now.

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ESTABLISHED 1868

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HEAVY PRESSURE, HIGH SPEED, etc.

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Yours truly,

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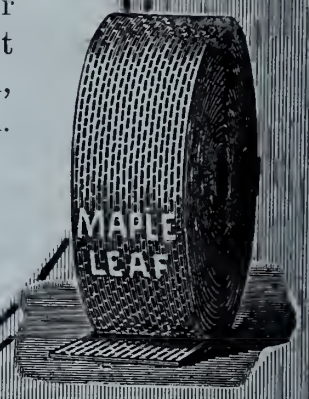
Write for prices and samples.



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Goes Right on Your Present Valve Wheel

"Goes on" is about right, too, it's so easy to apply, and by putting a

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on each of those hard-to-get at overhead valves you can save a lot of time you now spend in hunting ladders and all the risk you now run in using them after you've found them. One concern that thought two would do, bought 27 in a little over two months. The price will encourage you to have enough of them.

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Type A. D.—Driven by Air or Steam
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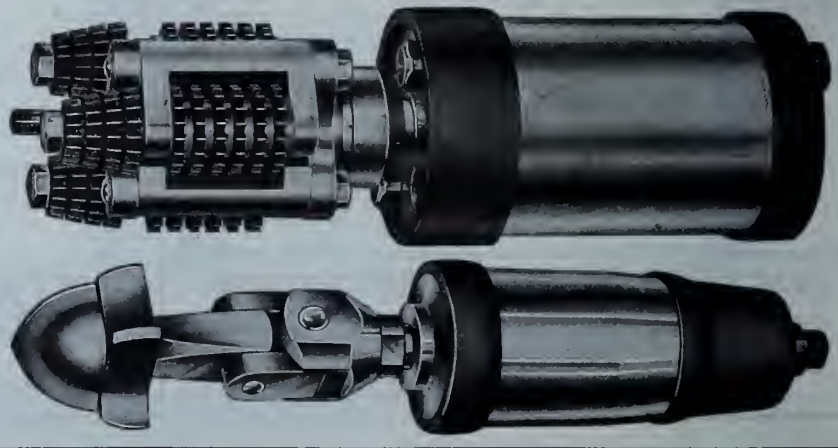
More power from your boilers.
Less coal per power produced.
No burned out boiler tubes.

The only cleaners for hardest scale.
Safest and fastest for light scale.
Best for all boiler scale conditions.
Standard of the largest power plants.



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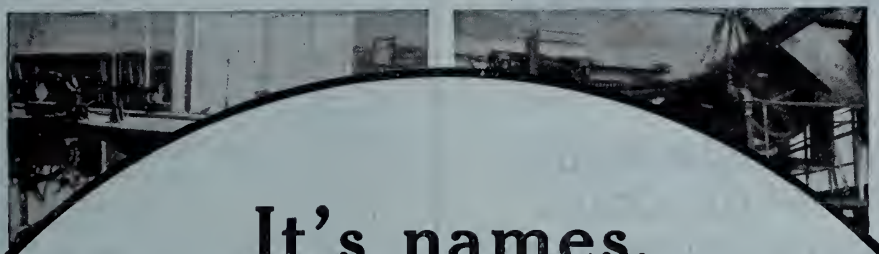
S. O. 3510—10 H. P. Morse Silent Chains driving lineshafts in an Ohio Tannery. Chains, 9/10" pitch, 2½" wide. Sprockets, 21/07 teeth, 30" center to center of shafts.



S. O. 26079-80—5 H. P. Morse Silent Chain driving lineshaft in a Knitting Factory. Chain, ⅝" pitch, 2½" wide, speed 893 F. P. M. Sprockets, 15/83 teeth, 1140/322 R. P. M., 15" centers.

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It's names, not dimes, that we want in exchange for our little Memo Book.

Those who *can* qualify for a free copy (see notation on sketch below) will appreciate why we ask others to pay for this book.

Without its 80 blank pages, this little book would be of interest and value ONLY to those who are interested in MORSE Silent Chains.

These 80 blank pages are added to the 48 pages of cuts and data on MORSE Chains for a single purpose—to make the book more useful to those who are interested in our product.

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TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A., PH. D., Superintendent, Trades & Labour Branch.

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Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

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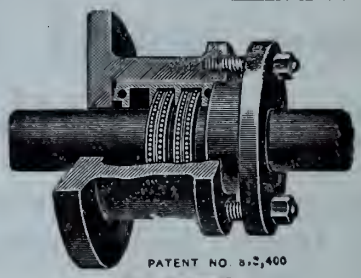

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Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

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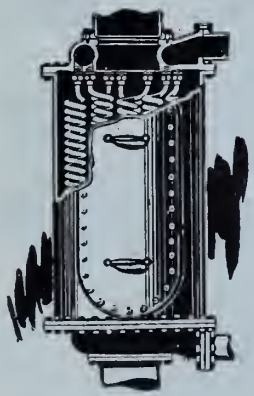

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Has greater capacity per square foot of heating surface than any other type of closed heater. It is simple in construction, light in weight and small in size.

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PROTECTO
BOILER PRESERVATIVE

Is not a water treatment but has an affinity for hot metal. After clearing your Boiler Plates and Tubes of Scale it forms a protective enamel to which further scale will not adhere. We are willing to give you thirty days' free trial and ABSOLUTELY GUARANTEE PURE STEAM. Prevents foaming or priming.

PROTECTOCOAT
For Coating Your Boiler Brickwork

Fills up present cracks and prevents new ones forming. Will last FOUR YEARS. Cold air penetrates all untreated brickwork and thereby reduces percentage of Carbon Dioxide in your chimney gases from the practical Maximum percentage of 14% to perhaps as low as 3%, entailing a loss per $1000 fuel of $15.00 to $535

Do you know that 1/16th inch Scale on inside of Boiler Shell will waste 13% of Fuel?

ELECTRIC PLANTS. We represent a maker of everything in Vulcanized Fibre products.

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The Goldie-McCulloch Co., Ltd.
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Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
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Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

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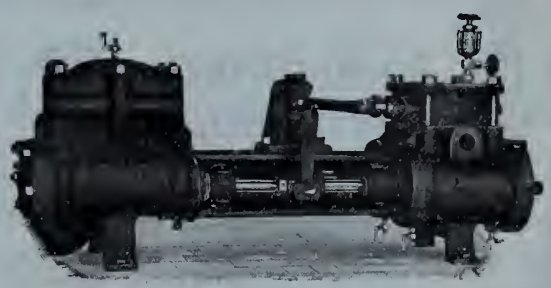

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SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

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WITHOUT RENEWAL

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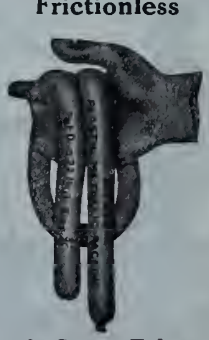

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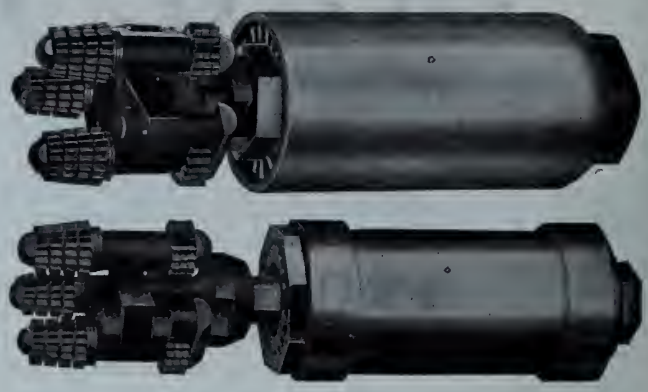
LAGONDA
BOILER TUBE CLEANERS

The latest Lagonda Water and Air-Driven Boiler Tube Cleaners are the most powerful and efficient tube cleaners made. They develop higher speed and greater power than has heretofore been secured with any Turbine Cleaner, and their use will materially shorten the time required in cleaning boilers.

These new Lagonda Cleaners are built for all sizes of tubes, either straight or curved, and they can be driven by water, air or steam.

Ask for Catalog L.



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The Lagonda Multiple Water Strainer in your water supply main will remove all objectionable solid matter and insure constant and economic conditions of pump and condenser operation. They are easily and quickly cleaned, without interruption of water supply, and take up small floor space. **Ask for Catalog R-2.**

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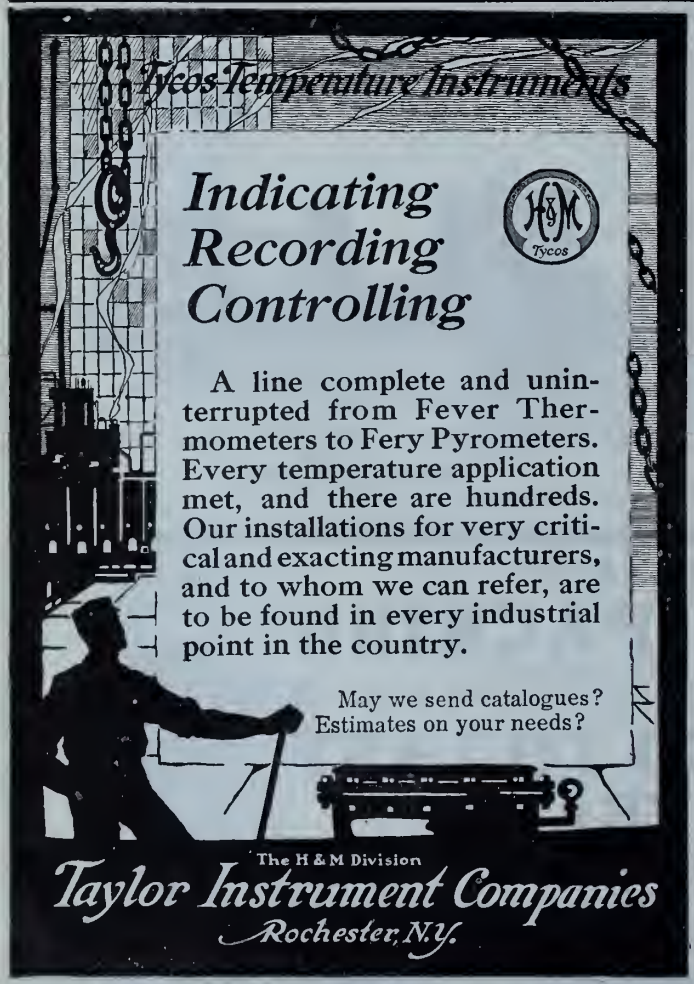
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H&M
Tycos
A line complete and uninterrupted from Fever Thermometers to Fery Pyrometers. Every temperature application met, and there are hundreds. Our installations for very critical and exacting manufacturers, and to whom we can refer, are to be found in every industrial point in the country.
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Estimates on your needs?
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TRADE MARK

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No Mercury is used. No multiplying devices in the actuating movement. All Bronze, non-corrosive material is used throughout. No steel is used except when specified. Three standard sizes—8 in., 10 in. and 12 in.—increasing or uniformly graduated charts as desired.

We guarantee every instrument to be Accurate and Durable under the hardest service.

Write for Bulletin No. B.H.96.

THE FOXBORO CO., Inc.
Foxboro, Mass., U.S.A.

PEACOCK BROS.
285 Beaver Hall Hill - MONTREAL

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York Manufacturing Co., York, Pa.

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C. C. Snowdon, Calgary.
Dominion Belting Co., Hamilton, Ont.
Federal Engineering Co., Toronto, Ont.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
American Pulley Co., Philadelphia, Pa.
Waterous Engine Works Co., Brantford, Ont.

BELTING, BALATA
Can. B. K. Morton Co., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Lyman Tube & Supply Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Plewes, E. B., Winnipeg, Man.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. B. K. Morton Co., Toronto, Montreal.
Federal Engineering Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren, Ltd., Montreal.
Plewes, E. B., Winnipeg, Man.
Sadler & Haworth, Montreal.

BELTING, RUBBER
Jeffrey Manufacturing Co., Montreal
Peerless Mfg. Co., New York, N.Y.
Quaker City Rubber Co., Philadelphia.

BELTING, TEXTILE
Federal Engineering Co., Toronto, Ont.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherhrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Sirocco Co., Windsor, Ont.
Coppus Eng. & Equip. Co., Worcester, Mass.

BOILER COMPOUNDS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Dearborn Chemical Co. of Canada, Toronto.
C. C. Snowdon, Calgary.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mf.g Co., Woodstock.
Dearborn Chemical Co., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Perolin Co. of Canada, Toronto, Ont.

BOILER FEED PUMPS
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Limited, Hamilton.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Peiler, H. L., Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

BOILER GRAPHITE
Joseph Dixon Crucible Co., Jersey City, N.J.

BOILER MOUNTINGS
Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Peiler, H. L., Montreal.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Canadian Griscom-Russell Co., Ltd., Montreal.
Peiler, H. L., Montreal.

BOILER SKIMMERS
National Steam Pump Co., Upper Sandusky, O.

BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittshurg.
Laurie & Lamb, Montreal.
Roto Co., The, Hartford, Conn.
Wm. B. Pierce Co., Buffalo, N.Y.

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Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Wayneshoro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherhrooke, Que.
Jones Underfeed Stoker Co., Toronto.
John McDougall Caledonian Iron Works, Montreal.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
McAvity, T. & Sons, Ltd., St. John, N.B.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Polson Iron Works, Toronto.
Waterous Engine Works Co., Brantford, Ont.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
John McDougall Caledonian Iron Works, Montreal.
Polson Iron Works, Toronto.
Waterous Engine Works Co., Brantford, Ont.

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D'Este Co., Julian, Boston, Mass.

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York Manufacturing Co., York, Pa.

BRINE TANKS
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Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Lunkenheimer Co., Cincinnati, O
McAvity, T. & Sons, Ltd., St. John, N.B.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Lunkenheimer Co., Cincinnati, O.
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McAvity, T. & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

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Waterous Engine Works Co., Brantford, Ont.

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Morse Chain Co., Ithaca, N.Y.

CHAIN HOISTS
Lyman Tube & Supply Co., Montreal, Que.

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C. C. Snowdon, Calgary.

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Jeffrey Manufacturing Co., Montreal.
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Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherhrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

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York Manufacturing Co., York, Pa.

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American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Belliss & Morcom, Birmingham, Eng.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Wks., Montreal.
Waterous Engine Works Co., Brantford.

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Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

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Elliott Co., Pittsburgh, Pa
Hare Engineering Co., Toronto.
Mason Regulator Co., Boston, Mass.
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Geo. H. Tod, Toronto,

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Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

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Terry Steam Turbine Co., Hartford, Conn.

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Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

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Jas. Morrison Brass Mfg. Co., Toronto.

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Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

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Can. Sirocco Co., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
John MacDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford.

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Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
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Jenckes Machine Co., Sherbrooke, Que.
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Elliott Co., Pittsburgh, Pa.
Hare Engineering Co., Toronto.
Jas Morrison Brass Mfg. Co., Toronto.
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Watson & McDaniel Co., Philadelphia.

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Canadian Griscom-Russell Co., Ltd., Montreal.
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Howard Iron Works, Buffalo, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

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Coppus Engr. & Equip. Co., Worcester, Mass.
B. F. Sturtevant Co., Boston, Mass.

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Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Canadian Griscom-Russell Co., Ltd., Montreal.
George W. Cole Co., Toronto.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Stewart Heater Co., Buffalo, N.Y.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Stewart Heater Co., Buffalo, N.Y.

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Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

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Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.

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Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Manufacturing Co., York, Pa.

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Quaker City Rubber Co., Philadelphia, Pa.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
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McAvity, T. & Sons, Ltd., St. John, N.B.

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Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

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Liberty Mfg. Co., Pittsburg, Pa.
William B. Pierece Co., Buffalo, N.Y.
Roto Co., Hartford, Conn.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Penberthy Injector Co., Windsor, Ont.

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FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

FRICTION LEATHERS
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FURNACES, BOILER
Gates, J. W., Montreal, P.Q.

FURNACES, SMOKELESS
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Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Micb.
Geo. H. Tod, Toronto.

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Penberthy Injector Co., Windsor, Ont.
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Uehling Instrument Co., New York, N.Y.

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Laurie & Lamb, Montreal.

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Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
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Foxboro Company, Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

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Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.

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The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

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Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
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Terry Steam Turbine Co., Hartford, Conn.

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Escher Wyss & Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

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C. C. Snowdon, Calgary.

GRAPHITOL
C. C. Snowdon, Calgary.

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Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Galt Foundry Co., Galt, Ont.
Hare Engineering Co., Toronto.
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Sbell Bar Grate Co., Toronto, Ont.
Geo. H. Tod, Toronto.
Waterous Engine Works Co., Brantford.

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Detroit Lubricator Co., Walkerville.
Hamilton Brass Mfg. Co., Hamilton, Ont.
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Jas. Morrison Brass Mfg. Co., Toronto.
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Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.
C. C. Snowdon, Calgary.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jos. Dixon Crucible Co., Jersey City.
C. C. Snowdon, Calgary.

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Goldie & McCulloch Co., Galt.
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Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
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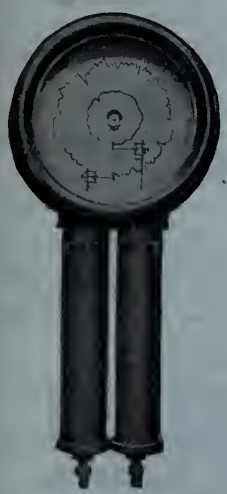

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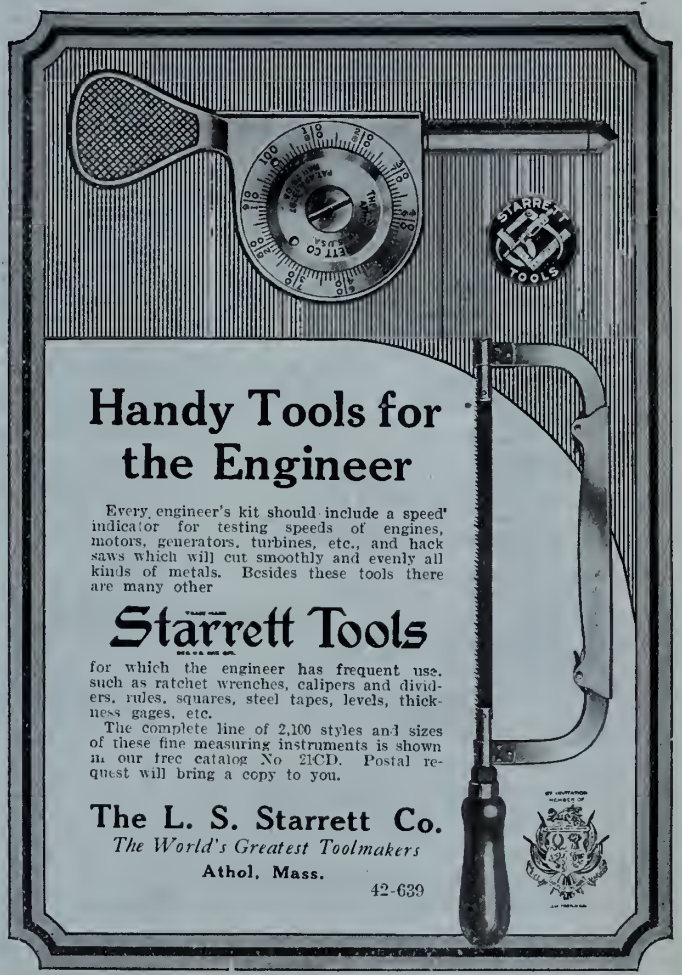

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Quaker City Rubber Co., Philadelphia, Pa.

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John McDougall Caledonian Iron Works, Montreal.

HYDRAULIC PRESSES
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

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Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

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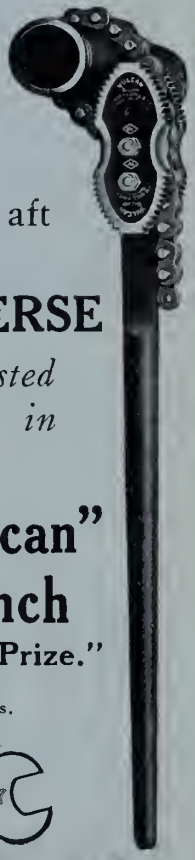

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Feb., 1917; 4th order 4—300 H.P. Units=1,200 H.P. First order was April, 1911. When these are installed will have 12—300 H.P.=3,600 H.P.

This is *40th repeat order* from Canadian users of Murphy Furnaces.

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For cooling water for Condensers, Transformers, Water Jackets, Ammonia Coils, etc., the Spraco System is preferable. A large number of Traction and Light Companies, Silk and Cotton Mills, Shoe and Leather Manufacturers, Ice and Refrigerating Plants, Mines and Smelters, Steel and Rubber Manufacturers USE "SPRACO" Cooling Equipment. There is a reason—it's Economical and Efficient. The "SPRACO" System of Cooling is supplanting the tower method everywhere on the strength of its merits. For instance—the "SPRACO" requires less power for operation; it is flexible, the tower is not; it uses less make-up water and the initial expense of the "SPRACO" is far below the tower system.

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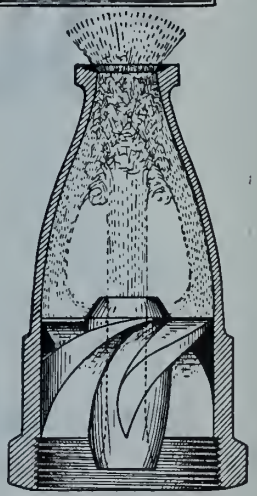

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is the power plant of the Ft. Worth Light, Heat and Power Co., Texas. On the inside the coal is stored above the boilers in a Brownhoist Concrete Bin, which time has proved will last as long as the plant and require no repairs. The coal is unloaded on the outside by a Brownhoist Locomotive Crane, which takes it from the cars and places it in storage or puts it through the roof into the Brownhoist Bin. It is safe to say that this plant will have very little trouble, if any, with its coal handling apparatus.

BROWNHOIST

Concrete Coal Bin and Coal Handling Machinery

Write for Catalog S

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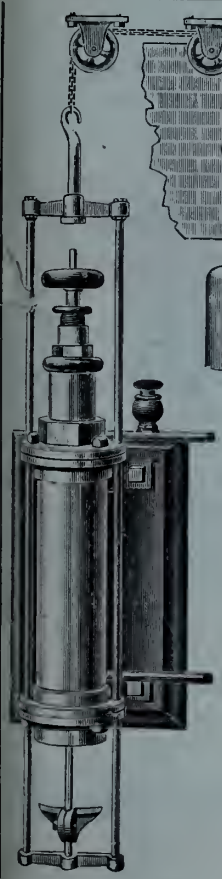
CLEVELAND, OHIO

Branch Offices in New York, Pittsburgh, Chicago, San Francisco, Montreal and (Portland, Ore., Colby, Eng. Co.)



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Is a device of unusual Simplicity, Durability and Power. Its operation is Positive and Automatic and it is Guaranteed to change the damper in either direction on a minimum variation of pressure. Therefore it is a Fuel Saver.

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Homestead Guaranteed Valves

are the best for all Water, Air or Steam Lines

Simple in construction, easy to operate, and the only valve which will successfully stand up under the heaviest duty service. Made in Straightway, Threeway and Fourway patterns. Special valves for special purposes.

There's a Homestead Valve for every purpose.

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Works: Homestead, Penna.

Our new circular, describing the Homestead in detail, is ready for you. Drop a card to-day for your copy.

If any advertisement interests you, tear it out now and place with letters to be answered.

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The Anderson Pressure Oil Filters are achieving wonderful results in purifying steam and gas engine lubricating oils, gas, gasoline and oil engine cylinder oils, cutting oils used on Automatic Machines and on draw benches, and for drying the moisture from and filtering transformer oils.

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Automobile and gas engine munufacturers are using the Anderson Pressure Oil Filters for oil used in the crank case of the engine when it is given the block or factory test. Before introducing the Anderson Pressure Oil Filters this oil was thrown into the sewer as it was found impossible to clean the oil economically by any other system.

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Don't confuse our Pressure system with the gravity system. We use direct pressure a method based on the same principle used by oil refiners.

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INDEX TO ADVERTISERS

A

	PAGE
Albany Lubricating Co.	65
Alberger Heater Co.	52
American Steam Gauge & Valve Mfg. Co.	50
American Steam Pump Co.	13
Anderson Co., V. D.	80
Armstrong Cork Insulation Co.	9

B

Babbitt Steam Specialty Co.	66
Babcock & Wilcox	70
Bawden Machine Co., Ltd.	7
Beveridge Paper Co.	69
Boiler Inspection Dept.	62
Boving Hydraulic & Eng. Co.	68
Bowser, S. F., & Co., Inc.	62
Brown Hoisting Machy. Co.	79

C

Can. B. K. Morton Co.	61
Can. Detroit Lub. Co.	65
Can. Fairbanks-Morse Co.	49
Can. Griscom-Russell Co., Ltd.	68
Can. Laco-Phillips Co., Ltd.	47
Can. Morehead Mfg. Co.	62
Can. Sirocco Co.	63
Can. SKF Co.	55
Chaplin-Fulton Co.	4
Cling-Surface Co.	63
Coppus Eng. & Equip. Co.	7
Crown Mfg. Co.	46

D

Darling Bros.	12
Dart Union Co.	57
Davis Regulator Co.	48
D'Este Co., Julian	79
De Laval Steam Turbine Co.	12
Direct Separator Co.	56
Dixon Crucible Co., Jos.	44
Dominion Belting Co.	66
Dominion Coal Co.	68
Durabla Mfg. Co.	50

E

Economy Fuse & Mfg. Co. of Canada	48
Elliott Co.	41
Escher Wyss & Co.	78

F

Foxboro Co.	70
Francis, Walter J., & Co.	44
Frick Co.	10

G

Galt Foundry Co.	4
Garlock Packing Co.	59
Garth Co.	68
Gates, John W.	5
Goldie & McCulloch Co.	16
Graton & Knight Mfg. Co.	53
Greene, Tweed & Co.	51

H

Hoffman, G. W.	45
Holmes Metallic Packing Co.	68
Homestead Valve Mfg. Co.	79
Hoyt Metal Co.	2

I

Inglis Co., John	Inside back cover

J

Jamison Cold Storage Door Co.	10
Jenckes Machine Co.	2
Jenkins Bros.	3
Jones Underfeed Stoker Co., Ltd.	5
Jordan Bros., Inc.	4

K

Kerr Engine Co.	58

L

Ladd, The Geo., Co.	69
Laurie & Lamb	11
Linde Canadian Refrigeration Works Co.	8
Lunkenheimer	58

M

MacGovern & Co.	75
MacKinnon, Holmes & Co.	44
Magnolia Metal Co.	65
Martel Packings Co.	50
Mason Regulator Co.	6
McAvity & Sons, T.	48
McDougall Caledonian Iron Works Co.	14
McGhie, W. C.	68
McLaren, D. K., Ltd.	19
Morris Machine Works	13
Morrison Brass Mfg. Co., Jas.	Outside back cover
Morse Chain Co.	67
Murphy Iron Works	77

N

Nashua Mach. Works	6

P

Peerless Rubber Co.	Inside front cover
Peiler & Co., H. L.	6
Penberthy Injector Co., Ltd.,	Outside front cover
Pennsylvania Flexible Metallic Tubing Co.	56
Pierce Co., Wm. B.	62
Plastics, Ltd.	52
Pratt & Cady Co.	54
Pulsometer Engineering Co.	43

R

Roto Company, The	66

S

Sarco Co., Inc.	45
"S-C" Regulator Co., The	13
Scaife, Wm. B., & Sons Co.	78
Schaeffer & Budenberg Mfg. Co.	7
Smart-Turner Mach. Co.	60
Smith, Fred	
Snowdon, C. C.	
Spray Engineering Co.	
Starrett, L. S., Co.	73
Steel Mill Packing Co.	69
Storey Pump & Equipment Co.	13
Sturtevant, B. F., Co., of Canada	43

T

Taylor Instrument Co.	70
Thomas Grate Bar Co.	4
Trimont Manufacturing Co.	75
Turbine Equipment Co., Toronto	12

U

Uehling Instrument Co.	73

V

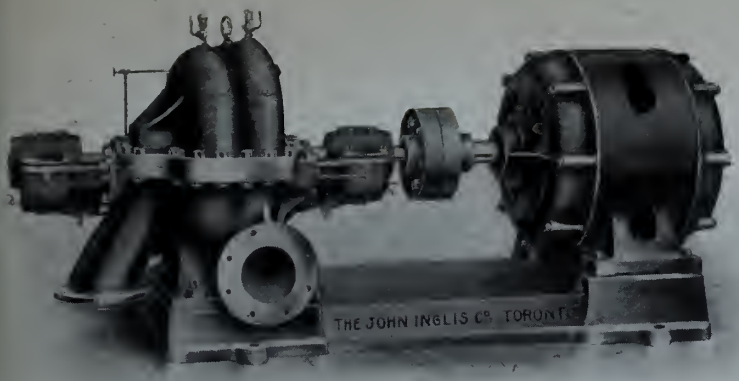
Vilter Mfg. Co.	8

W

Wall, W. J.	45
Waterous Engine Wks Co.	1
Watson & McDaniel Co.	68
Williams & Co., J. H.	75

Y

York Mfg. Co.	9



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for medium and high pressures

DIRECT CONNECTED TO ELECTRIC MOTOR

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Oil-ring bearings, hydraulic balance, and water-cooled thrust bearings are standard for all *"Inglis"* Turbine Pumps.

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Illustration Below Shows Our

Double Suction Pump

for circulating low or medium heads

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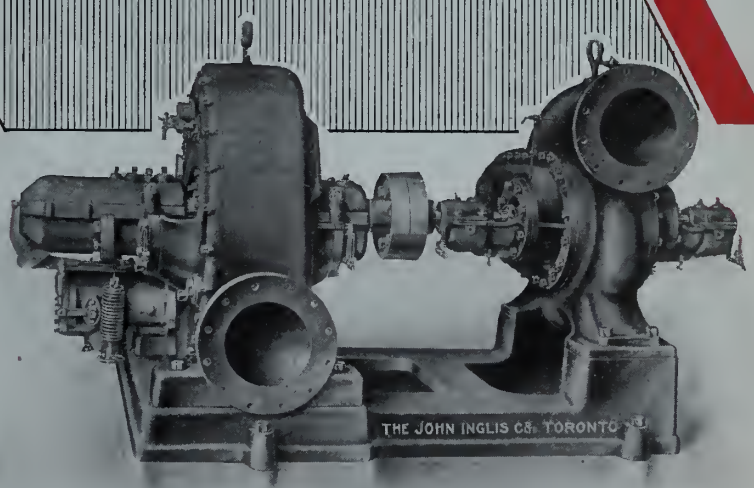

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Engineers and Boilermakers

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against inferior service when you buy

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See that it's on the Boiler Mountings, Steam Specialties and Engine Supplies that you buy—and you'll make sure of getting a superior service in every way.

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Our Steam Goods are approved by Provincial and Marine Inspection Departments.

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89-97 West Adelaide Street

TORONTO ONTARIO

THE POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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MONTREAL: Eastern Townships Bank Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 22 Royal Bank Bldg.

Vol. X Publication Office, Toronto—April, 1917 No. 4

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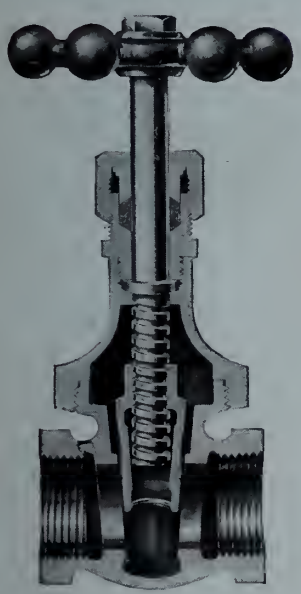
Exterior View
Note outside bonnet construction



Sectional View
Note outside bonnet construction

TRADE PENBERTHY MARK

BRASS GATE VALVES

APPROVED AND REGISTERED

All Penberthy Gate Valves have the

OUTSIDE BONNET CONSTRUCTION

STRONG WHERE OTHERS ARE WEAK

This Gate Valve

In design, workmanship and material represents the modern, efficient, up-to-date methods of factory production. The best mechanical ideas of the present day are incorporated in this new gate valve, and the defects of faulty design, inferior construction and workmanship of other types entirely eliminated.

The Outside Bonnet

Construction in Penberthy Gates, Globes and Angle Valves is *not* a fad nor a selling point. It *is* mechanically and practically the *correct idea,* and is acknowledged so by leading experienced men in the business.

The solid wedge gate, the packing gland follower, the liberal and even distribution of good steam metal, the fine workmanship, etc., make this valve

"The Gate That's Up-to-Date"

Made in Canada by

Penberthy Injector Co., Limited, Windsor, Ont.

Makers of High-Grade Valves

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IN THE PLANT WHEN

RAINBOW RED SHEET

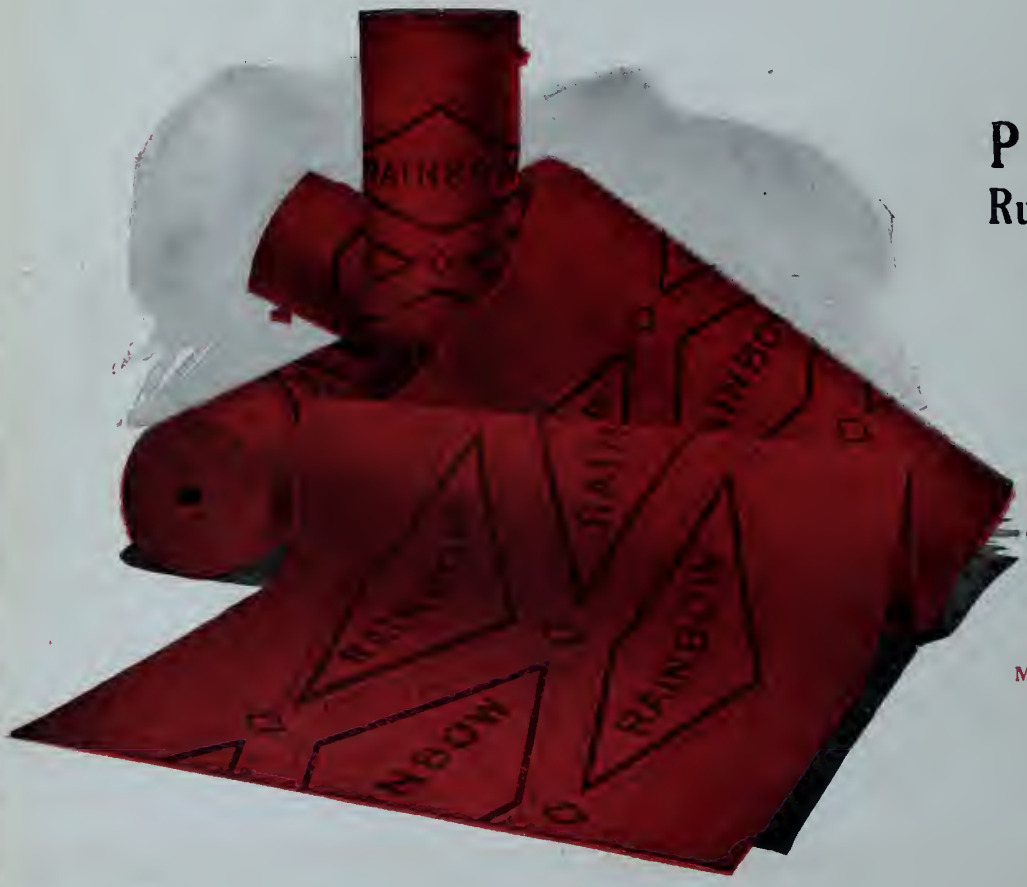
IS IN THE FLANGES.

IT IS YOUR INSURANCE AGAINST

"SHUT-DOWNS" THAT ARE SO COSTLY

TO THE BUSY MANUFACTURER.

USE IT ON THE NEXT JOINT YOU PACK



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Carry a large stock
of all sizes
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Waterous Boilers

WATEROUS Boilers are built in types and sizes to suit every service.

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Portable Locomotive Boilers—20 to 100 H.P.

Vertical Boilers—6 to 25 H.P.

Special and Marine Boilers—all sizes.

Clean cut construction and honest workmanship distinguish these boilers. They are built for both power and heating purposes, better than required by law.

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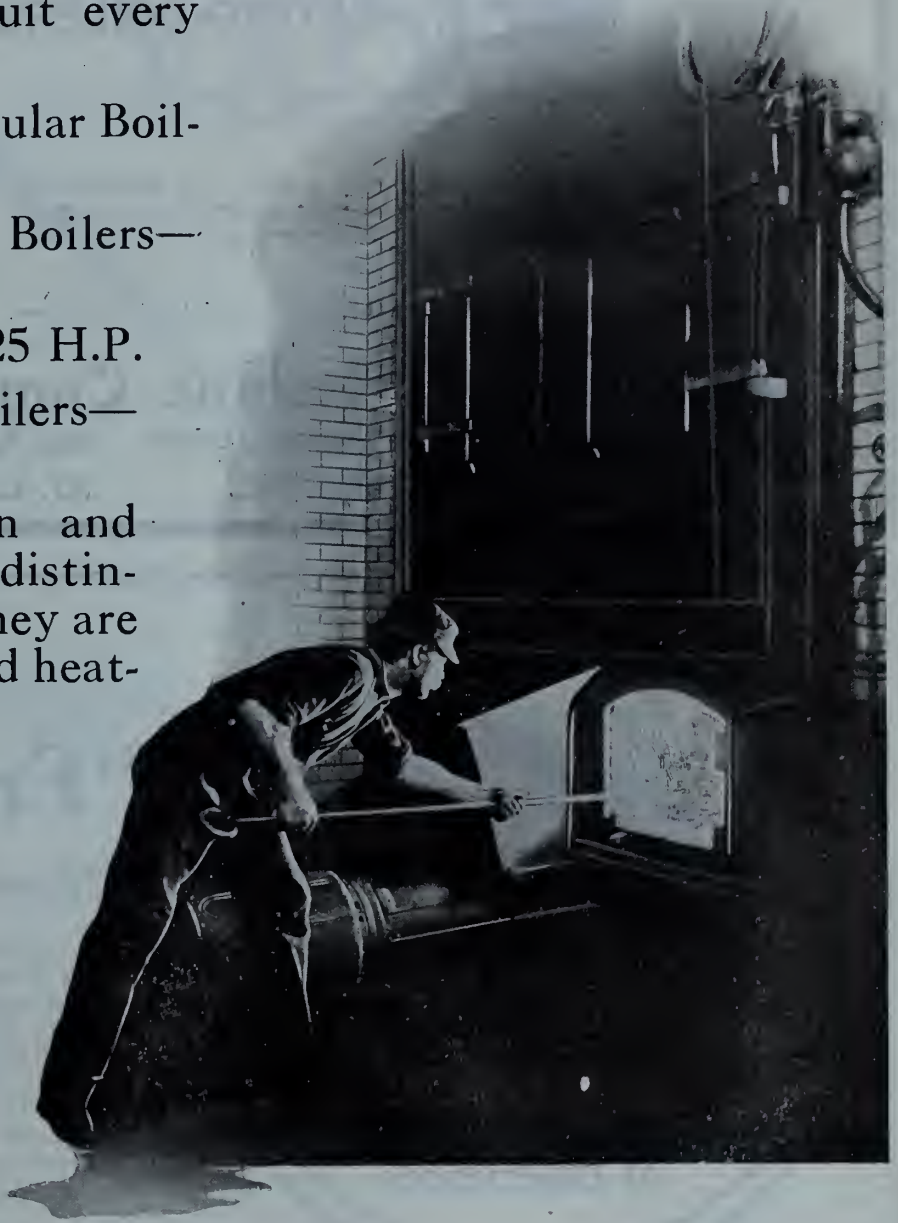
Our new catalogue—No. 506 —is at your service.



The Waterous Engine Works Company, Limited

BRANTFORD - CANADA

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HIGHEST QUALITY

JENCKES BOILERS

VERTICAL TUBULAR
HOROZONTAL TUBULAR
LOCOMOTIVE TYPES
HEATING BOILERS

Jenckes Boilers Built in all Sizes.

Made to Conform to any Provincial Act

When you take into consideration the service they give Jenckes Boilers are the most economical you can buy—Liability to stoppage for repairs is almost negligible.

They are safe and sure. Flange quality steel, conforming to manufacturers' standard specifications, used in shell heads—tubes made of lap welded steel of standard gauge and make—rivets of special steel—stays of carefully selected wrought iron or steel.

Write for catalog; it will explain further the excellent points of our boilers.

The Jenckes Machine Company, Limited

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Works: SHERBROOKE, QUE. ST. CATHARINES, ONT.

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Backed by 40 Years of Experience

Hoyt "Frost King"

Scientifically Prepared

There is no guesswork in the manufacture of Hoyt Babbitt Metals. Our "Frost King" brand formula has been prepared by our laboratory experts, who keep close watch that the standard of excellence is always maintained. That's why you can always depend upon its quality.

It is a heavy duty metal and has no peer anywhere. Used extensively for Engines, Pumps, Rolling Mills, Pulp Machinery, Planing Mills, etc.

Order from your dealer—if he can't supply, have us ship you a 25-pound trial box direct.

"NICKEL GENUINE"—Have you tried it? We specially recommend this metal for babbitting dynamos and motors. There's a decided difference between Hoyt Products and other babbitt metals, and you find this fact strikingly exemplified in "Nickel Genuine" and "Frost King." Give them a test—you can't go wrong!

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Fig. 300
Jenkins Bros.' Type "K" Standard Pattern Brass Gate Valve Screwed

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MADE IN BRASS AND IRON BODY

For Use on Steam, Water, Air, Oil or Gas

The most serviceable Gate Valves ever made—have our Diamond Trade-Mark cast on body, which stands for all that is best in design, material and construction.

Catalogue No. 8 sent free on request.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

103 ST. REMI ST. MONTREAL

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Murphy AUTOMATIC Furnace

British Cordite Ltd.

Executed Contract

January, 1917, for 10—400 H.P.

Murphy Furnace Units

= 4,000 H.P., for installation at Nobel, Ont.

Spanish River Pulp & Paper Co., Ltd., Espanola, Ont.

Feb., 1917; 4th order 4—300 H.P. Units=1,200 H.P. First order was April, 1911. When these are installed will have 12—300 H.P.=3,600 H.P.

This is *40th repeat order* from Canadian users of Murphy Furnaces.

Since January 1st, 1917—13 REPEAT ORDERS, covering 26 furnaces= 9,250 H.P.

For printed matter address

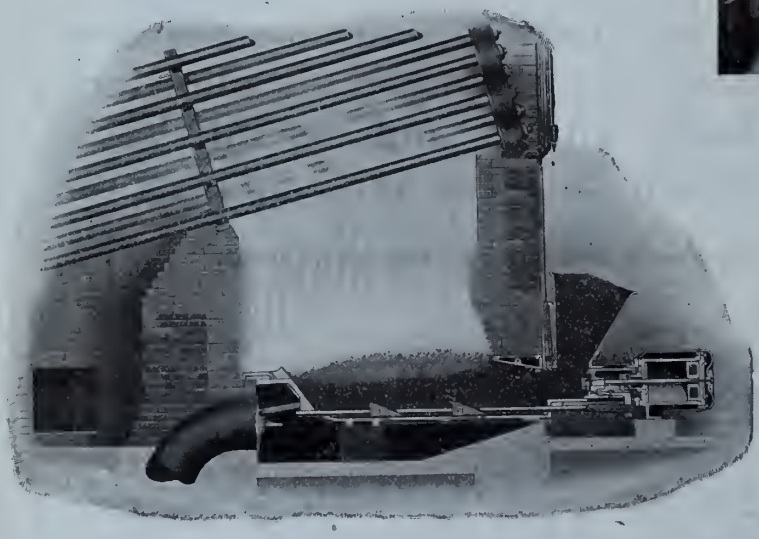
MURPHY IRON WORKS, BUFFALO, N. Y. DETROIT, MICH.

There's No Money Going Up In Smoke with the JONES

UNDERFEED STOKER

In Operation

Where they are installed chimneys never smoke—you lose no money in wasted fuel. This, coupled with uniformity of coal supply, saves up to 25% in fuel.



No Losses Through Grates—There Are None

Simplicity is another of its cardinal virtues. No parts move in contact with fire. Works with very little attention and saves much labor. Does away with a lot of fire worry. Burns less coal and cheaper coal. You get a steady steam pressure, regardless of load.

Would you like to get in touch with some users of this stoker? Write to us.

Jones Underfeed Stoker Co., Limited

37-41 Britain Street TORONTO

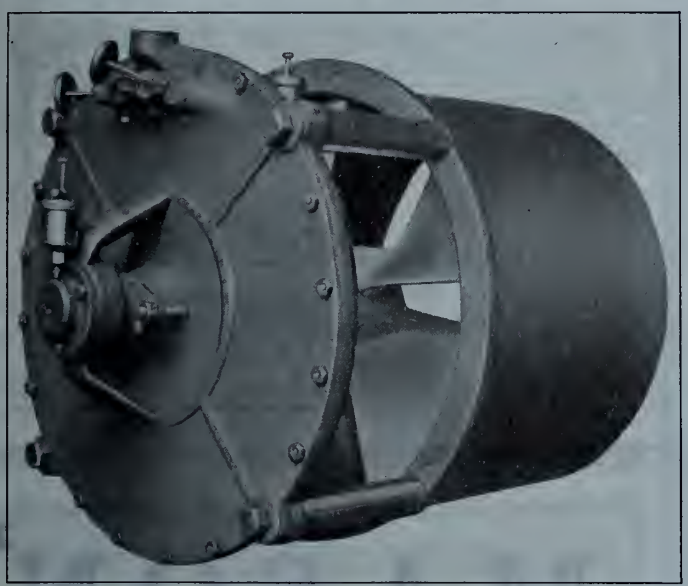
Economy and Efficiency

in Operation are the Chief Characteristics of Successful Concerns such as:

THE T. EATON CO. LIMITED
and
The Hamilton Cotton Co.
LIMITED
(Their third order this year)

who have just ordered

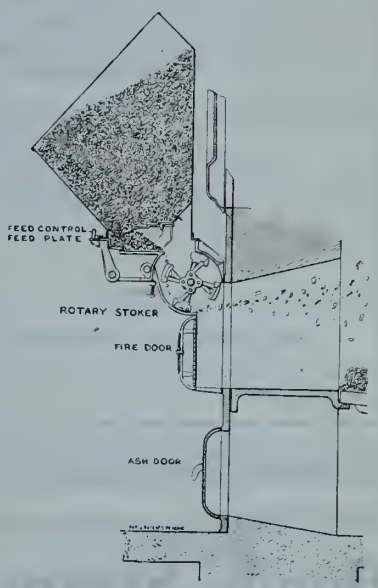
12 Galt Sprinkler 3 Stokers



POWER TURBO-BLOWER.
(Note the individual Nozzle Control). Steam turbine efficiency cannot possibly be obtained by throttling a Globe Valve. The individual nozzle is the only way.

Galt Sprinkler Stokers are the essence of simplicity and high-grade workmanship. They operate with either natural, forced or induced draft.

Our Power Turbo - Blowers are used in every part of the world and can be employed independently or in conjunction with stoker. Cheap—poor coal, peak loads and low smoke stacks have no terror for our equipment.



The stoker mechanically feeds and uniformly spreads any type of fuel in a light continuous stream over the entire surface of your present fire grates. The ideal method of burning coal.

Ask for Catalogues on Stokers, Grate Bars, Blowers, Damper Regulators, Etc.

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Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

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FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

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THE simple matter of buying goods at one price and selling at another never made a successful business. The ***Element of Service*** is what adds permanence to any organization, and the success of such organization is measured only by its ability to serve. The factor of ***SERVICE***—to the customer—always has been, and is, what has guided us in making connections with manufacturers of power plant specialties.

WE have had many years' experience solving difficult power plant questions, of all kinds and conditions, and the benefit of this experience is yours in dealing with us. If your conditions are not suitable for equipment supplied by us, we do not hesitate to advise what we think will overcome your difficulties.

ON this, and the opposite page, a few of our lines are shown. In our opinion, after long experience, with many tests and trials, they are the best, will stand up the longest, and give the most efficient service, of any that are made on the continent.

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We solicit your enquiries.

Bundy Steam Traps

When you get heat into water, keep it there! Keep it there and hold it there as long as possible, no matter where the water goes. This is the idea which the makers of the

BUNDY STEAM TRAPS

have been driving home to power plant men for years.

BUNDY STEAM TRAPS
combine Power, Simplicity and Efficiency

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Reducing Valves

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If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

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WHEN you can increase your present steaming capacity to 200 and in connection with stokers even 300% of the normal rating of the boilers without injury to the boilers by installing a

COPPUS TURBO BLOWER

You will have all the steam you want all the time. Hundreds of satisfied customers will attest to this. No drop in steam pressure when a heavy load comes on and you can laugh at the weather man, as you can dispense with him for your draft. Besides the blower will pay for itself in a short time, as it will burn cheaper fuel.

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500,000 H.P.

in boiler equipped with Coppus Turbo Blowers in four years.

The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

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The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

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Power Plant Thermometers—for feed water, economizer, condenser, flue gases, etc., etc., are fully illustrated and described by Catalog Section No. 200. Our "Crescent" Thermometers are featured in a complete line, as are also our "Reform" Mercury Actuated Dial Thermometers which are now so universally used in Power Plants.

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No need of explaining the absolute necessity of recording feed water, economizer, condenser, and flue gas temperatures. Our "Columbia" Recording Thermometer is acknowledged by many prominent Engineers to be "just superior all 'round," Mercury Actuated, Steel Construction. Day and Night Border Charts, Glass Interchangeable Pens, Easy Chart Changing, etc., etc., etc.

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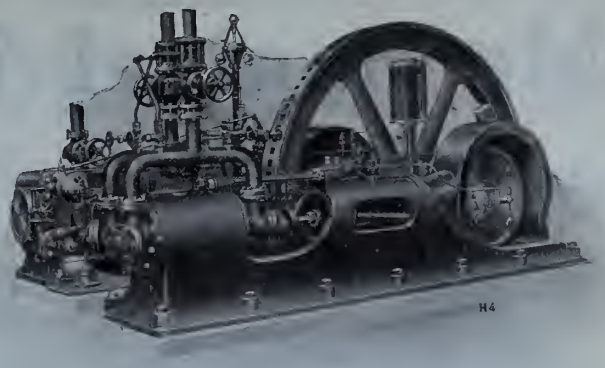

means a successful run, when the plant is Built by "Frick" the builders of the

MAXIMUM Economy-Endurance

Ice Making Machines for 35 years.

Hundreds of them are proving this every season.

Write us your needs.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives: Frick Ice & Refg. Co., Montreal, Canada

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One of the strongest points in favor of Nonpareil Corkboard is the ease with which it is erected in existing buildings—either concrete, brick, hollow tile or frame. This feature made it possible for the Chicago Cold Storage & Warehouse Company to lease the Soo Line Terminal Buildings, Chicago, Ill., insulate the rooms and secure a large amount of cold storage space in much less time than it would have taken to build a new plant.

Insulating concrete ceilings with Nonpareil Corkboard in the cold storage rooms of the Chicago Cold Storage & Warehouse Co., Soo Line Terminal Building, Chicago, Ill.

In buildings of this type

Nonpareil Corkboard Insulation

For all Cold Storage Rooms

is laid up against the walls, ceilings and columns in Portland cement mortar. A perfect bond is thus secured and no supports or retaining walls are required after the mortar has set. Portland cement plaster is then applied to the surface of the corkboard, giving a sanitary finish. For insulating concrete floors, Nonpareil Corkboard is laid down in hot asphalt and a concrete or wooden wearing surface applied on top.

It is the remarkable structural strength of Nonpareil Corkboard that makes it so easy to install. This, however, is secured with no loss of heat insulating efficiency. Due to the sealed air-cells of the cork and the absence of any foreign binder, Nonpareil Corkboard has the highest efficiency of any commercial heat insulating material.

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In the application of Mechanical Refrigeration in the various trades, we can be of real service to prospective users in suggesting Refrigerating Equipment that will meet the conditions most efficiently and economically.

Our Engineering Department, which is constantly in touch with these problems, is at the service of any one contemplating the use of Mechanical Refrigeration.

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We invite correspondence on any subject pertaining to the application of Mechanical Refrigeration.

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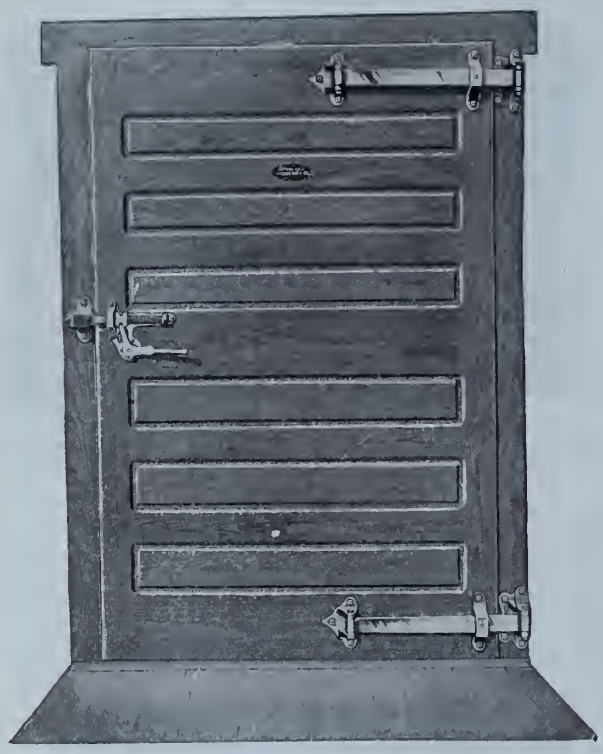

DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because :

1st—Only the best materials are used in their construction.

2nd—We use heavier materials. Result: Longer life and increased efficiency.

3rd—Our doors are built with double and triple seals of contact—others have but one.

4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.

5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

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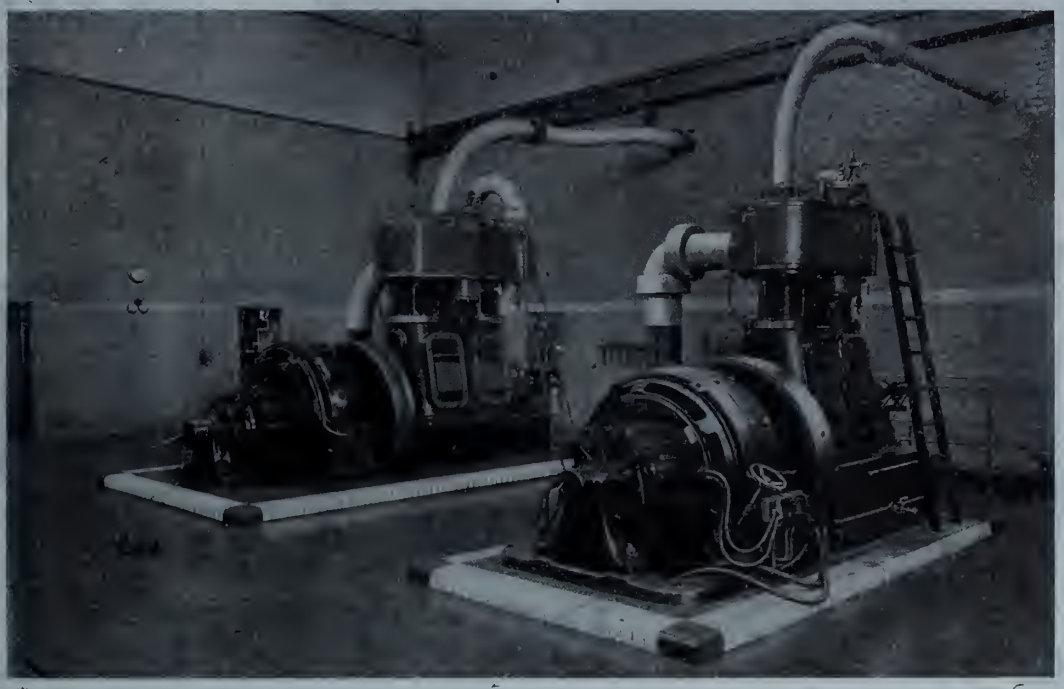
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
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BALATA BELTING

THE BELT WITH A GRIP

You cannot get steady and regular driving out of belts that stretch and slip.

ANY MAKE of BELT will **GRIP WHEN NEW** BUT

"LINCONA" retains its natural
GRIP ALL ALONG

Maximum Transmission of Power with Highest Degree of Efficiency.

The Canadian B. K. Morton Co., Limited

MONTREAL
49 Common Street

TORONTO
86 Richmond Street East

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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London Engine Supplies Co., London, Ont.
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Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American-Marsh Centrifugal Pump.

American Steam Pump Company

Battle Creek, Mich.

"Put it up to Darling Bros."

If you have trouble with your present system, or require anything new in steam appliances—put it up to "Darling Brothers"—let them solve your problems.

Their first quality steam appliances, plus many years of experience at solving troubles in the power plant, will make things go smoothly for you.

"Always tell Darling Bros. your troubles."

DARLING BROTHERS LIMITED, MONTREAL, P.Q.

Head Office and Works: MONTREAL

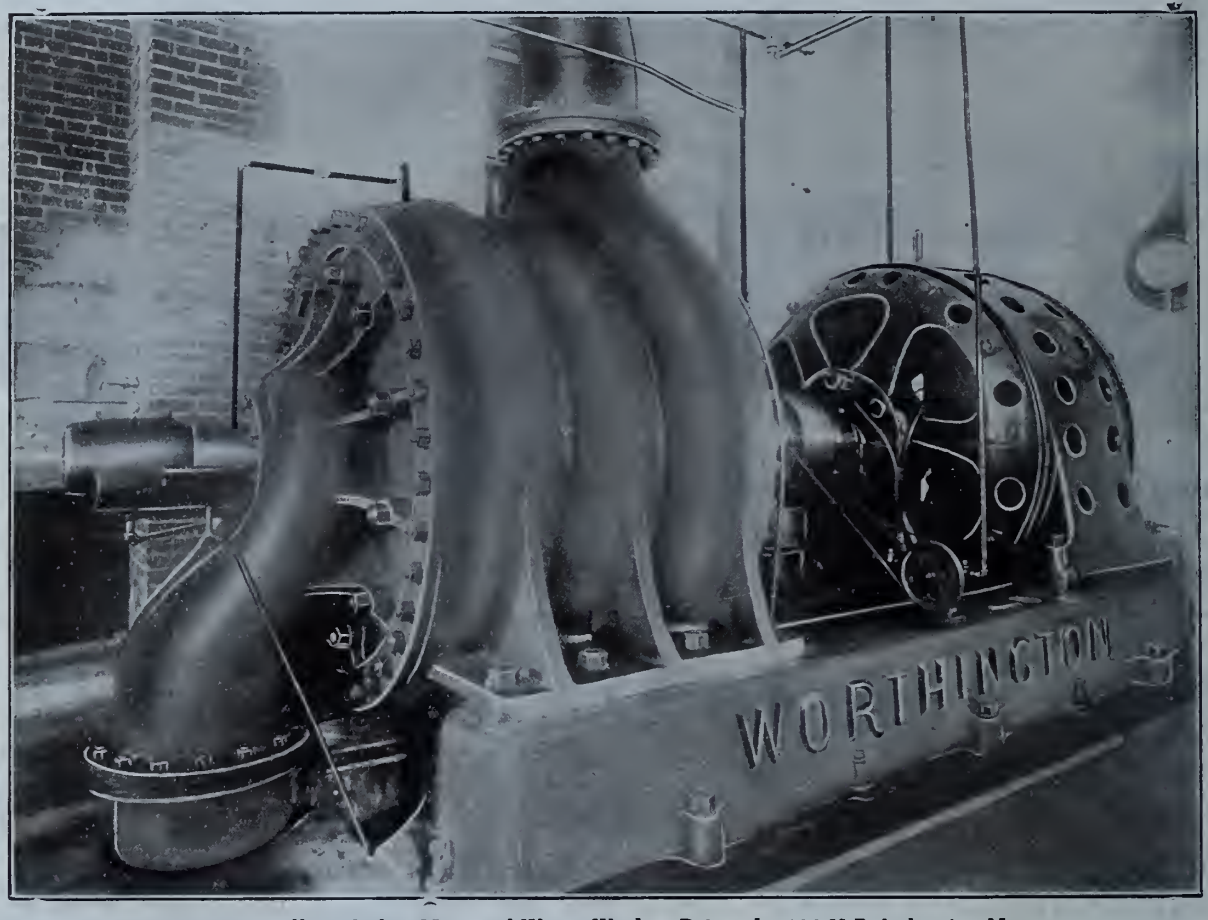
TORONTO **WINNIPEG** **VANCOUVER**

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works: Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO April, 1917

An Address before the Technical Publicity Association in New York

By Mr. Geo. H. Gibson

THE application of science proceeds at an acelerated pace. The days have about gone by when one good idea would keep a family in business for several generations. No one dare rest content, for as Solomon remarks, "Yet a little sleep, a little slumber, a little folding of the hands to sleep, so shall thy poverty come." Every manufacturer, and particuarly manufacturers of engineering appliances and products, must maintain a constant output of improvements and new developments in order to protect his investment in plant, organization, and good will, and indeed, to stay in business. As has justly been said, the invention of a new machine or process—by some one else—may be as disastrous as a fire, and far more likely to occur.

Moreover, the more progressive, the more advanced, a concern is, the greater will be its volume of new developments and improvements. Inventions breed inventions.

At the same time, the investment of time and money in research and development is a capital risk, that is, the preliminary investigation upon which the design of improved apparatus is based and the provision of manufacturing equipment and organization for turning it out must largely be paid for before the market for it can be developed. It is only by the prompt enlightenment of the prospective consumer, in other words, by educational advertising regarding the applications and advantages of the new article that the loss of time and the waste which always intervene between the perfection of a device or process and its general use, can be reduced.

The introduction of new things is a speculative venture which bars the timid—but for that very reason is highly profitable. Patents more or less effectively insure to the originator a safety zone, protecting him from competition for a limited period that he may have the opportunity to recover his great initial outlay. Advertising, however, is equally useful, since it can shorten the period of loss, conserving for profit-making a greater portion of the 17 years' monopoly conferred by the patent and increasing the volume of profit. *Advertising itself exerts an accelerating influence on technical development, for before advertising, one should have something worth advertising.* Much of the strategy in the competitive selling of engineering appliances consists in originating better methods or designs, or new and improved products.

Good business has been defined as the art of selecting probabilities, and it is certainly true that the greatest successes in the engineering business have come to men who had the ability to do the following things:

(1) Foresee the need or opportunity,
(2) Develop the solution, and
(3) Focus the attention of the public upon the problem and its solution.

AS EXAMPLES, I might mention Edison with the incandescent lamp, Westinghouse with the air brake and alternating current transmission, Hunt with rope transmission, Sturtevant with fans and blowers, De Laval and Parsons with the steam turbine, Babcock and Neier with the water-tube boiler, Diesel with the oil engine, the Wheelers with surface condensers, Hill with technical journalism, Thurston with technical schools, Patterson with the cash register, Herschel with water meters, Kent with his handbook, and many others.

The inertia and prejudice which must be overcome in the introduction of a new device may be illustrated by the experience of Corliss with his variable cut-off, four-valve steam engine. After he had perfected and demonstrated the remarkable savings of his engine as compared with the engines then common in this country, he was still compelled to give the engines away and to take his payment in the fuel saved during the first year's operation in order to make headway.

Many people have the idea that the invention is the important thing. Very few engineering businesses, however, are founded altogether on exclusive and basic patents. They are based rather on a combination of scientific knowledge and business sagacity, with the help of such protection, monopoly or trading advantage as can be obtained from the detail patents which it may be possible to secure as the development of the art unfolds itself. A man may have the germ of a good idea for a successful business, but still nothing that can be protected by a patent, even though patentable improvements will doubtless be discovered upon developing the idea. Nevertheless, the essential factor is the broad judgment or foresight which leads him to take up certain matters at a particular juncture, and not the specific mechanical contrivances by which he may carry out his ideas. *In such cases, the best protection to the idea is advertising by means of which he can promptly get the full benefit of the potential demand for his product before competitors have had time to imitate and develop. Once he has his organization and business well under way, competition will be at a disadvantage.*

ENGINEERING PRODUCTS are purchased almost solely for their utilitarian value. Their usefulness can be weighed, measured or computed in some way, and they are usually purchased with much deliberation, for the reasoning faculties of the people who buy them have been emphasized by technical and business training.

The advertising should arise from and carry forward the general ideas and beliefs of the guiding mind of the business It finds inspiration in new products and the exploitation of new fields. As compared with this broad purpose, the means and methods discussed in books on advertising, such as typography and display, color of ink, quality of paper, etc., are to a degree only incidental—all that is asked of them is that they should do their part in transferring ideas efficiently and not get in the way of the main motive, which is the making use of the spectacular qualities of advancement and improvement and the doing or saying of things interestingly.

The world is run largely on ideas and the dissemination of ideas is the business of the advertising engineer.

THE POWER HOUSE

143-153 University Avenue, Toronto, Ontario

POWER EQUIPMENT

ENGINES

BOILERS

2-G & McC. Sectional Water-Tube Boilers at St. Boniface Hospital, Winnipeg, Manitoba.

CONTINUOUS SERVICE *in your power plant means—* **UNINTERRUPTED PRODUCTION**

and in these days of rush, such production is of the greatest importance. The prime factors in this continuity of operation are your ENGINES and BOILERS. G. & McC. Co. Power Equipment is designed and built as a means to supplying this

MUCH-TO-BE-DESIRED CONTINUOUS AND ECONOMICAL SERVICE

Catalogs, Plans, etc., will be mailed to those interested upon request.

THE GOLDIE & McCULLOCH COMPANY, LIMITED

Head Office and Works - - - - - GALT, ONTARIO, CANADA

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

Power Plant of the Hudson's Bay Co. Store, Vancouver, B.C.

By A. F. Menzies

From the illustrated descriptive articles appearing in our columns from time to time, covering modern power plant installations, it will be readily apparent that public buildings, institutions, and commercial establishments compare favorably in the matter of equipment, with those more directly auxiliary to manufacturing enterprise. In either case, however, success is largely, if not altogether dependent on the individual, and combined efficiencies of the units installed. That both features have been given prominence here is easily discernible.

THE Hudson Bay Co., justly noted throughout the country for doing things properly, did not trifle with their reputation when they considered the power plant in connection with the recent addition to their Vancouver store. The addition to the building is a sizable affair in itself, while the power plant "down-under" carries the load for both old and new buildings. The original building occupies the corner of Granville and Georgia Streets, while the addition occupies the corner of Georgia and Seymour Streets. Together, the buildings take up the whole frontage of the block on Georgia Street.

Steam is supplied by two 300 horse power Babcock & Wilcox water tube boilers, built at Renfrew, Scotland, and supplied by C.C. Moore & Co. of San Francisco, Cal. The heating surface of each boiler is 3135 sq. ft., and the working pressure allowed by Provincial Rules is 160 lbs. per sq. in. The boilers are arranged in individual brick settings, the bricks exposed in front having white glazed faces. Fig. 1 shows the arrangement of the boilers, the column in the middle of the illustration being one of the supporting columns of the building. Large well lighted pressure gauges are provided, while the water gauges have extension handles enabling the cocks to be blown through and shut off from the working platform. There are two Lukenheimer blow-off valves attached to the mud drums of each boiler, in addition to the blow-off cocks provided by the makers of the boilers.

Oil Fuel

In common with a large number of other power plants on the Pacific Coast, this plant uses liquid fuel. The oil is stored in two 8 ft. 6 in. x 18 ft. steel tanks located below the stokehold floor. The tanks were built by the Vulcan Iron Works of New Westminster, B.C. They are filled from the street level, and are provided with gauges indicating the amount of oil remaining in them. The fuel is supplied by the Imperial Oil Co.

Oil and Feed Water Pumps

From the tanks, the oil is pumped by a pair of 4½ ins. x 2¾ ins. x 4 ins. steam driven, Knowles duplex pumps. One pump is capable of handling the work the other being kept as a stand-by. They are, of course, piped up so that switching from one to the other can be done without loss of time. The pressure in the oil lines is controlled by a Mason regulating valve operated by the oil pressure and operating on the steam supply to the pumps. A by-pass is provided to cut out the regulator when starting up. Before reaching the burners, the oil is heated in a live steam heater and passed through filters installed in duplicate to remove any fine particles of solid matter.

Steam is used for atomization purposes, and the steam and oil pipes can be seen entering the ashpits in Fig. 1. The system was supplied by the Leahy Mfg. Co., of Los Angles, Cal. A check on the oil consumption is provided in the shape of a Worthington piston oil meter which registers in gallons.

FIG. 1. BABCOCK & WILCOX WATER-TUBE BOILER INSTALLATION.

Feed water is handled by a pair of Canadian Fairbanks-Morse outside packed, duplex pumps, each 8 ins. x 5 ins. x 10 ins. The condensate from the exhaust steam heating system is used, and make-up is obtained from the Vancouver City water mains. All feed water is passed through a 3 ins. Venturi water meter made by the Builders Iron Foundry of Providence, R.I. The meter records the amount of water passing, and indicates the instantaneous amount in thousands of pounds per hour. A Standard Speciality Co. feed heater and purifier is provided which heats the feed to from 206 to 210 degs. F.

The feed and other pumps are set on foundations about a foot above the surrounding floor, the visible part of the foundation being faced with white brick, see Fig. 7. The pumps stand in large cast iron drip trays which drain to the sump. As these trays are very large, they enable the floor round the pumps to be kept like the rest of the plant—spotlessly clean. The feed pumps are located behind the boilers, and beside them are a pair of Canadian Fairbanks-Morse 10 ins. x 14 ins. x 12 ins. simplex vacuum pumps. These drain the condensate from the heating system and discharge it into the feed heater. The vacuum pumps are provided with automatic control and a by-pass.

Sump Pumps

As the power plant is considerably below the sewer level, a sump has been provided into which all drains discharge. The sump is kept clear by two motor-driven centrifugal pumps under automatic control. The pumps were supplied by the Byron-Hackson Co. of San Francisco, and are capable of delivering 240 gals. per minute each against a combined head of 25 feet. They are direct connected to 5 h.p., 1100 r.p.m. Westinghouse motors. The automatic control device, worked from a float in the

sump was supplied by the Cutler-Hammer Mfg. Co. of Milwaukee, Wis. As a stand by to drain the sump when the generators are shut down, a 5¼ ins. x 5 ins. x 5 ins. steam driven duplex pump is provided.

The engine room is spacious, being about 36 feet by 110 feet. In it are the two electric generators and the switchboard. The generators are mounted on the crank shafts of Goldie & McCulloch Corliss engines. The latter have 19 ins. x 30 ins. cylinders, and turn up 150 r.p.m. They are provided with double ported Corliss valves operated by eccentrics, separate eccentrics being provided for the steam and exhaust valves. Journal lubrication is provided for by a Richardson-Phoenix oil system. The oil is delivered to the journals through sight feed glasses by a 2½ ins. x 1½ ins. Gardner duplex pump, and returns to the filter by gravity. A thermometer is provided on the filter to give the oil temperature. To care for cylinder lubrication, a Richardson automatic sight feed lubricator is provided and is operated from the valve gear.

Fig. 2 is a view along the engine room while Fig. 3 shows the valve gear side of No. 2 engine. The cylinders are provided with indicator cocks and relief valves at each end. To insure a supply of dry steam to the cylinders, large vertical steam separators are located just above the stop valves. As shown in Fig. 3, Rites inertia governors are provided to care for speed regulation. The governors are belt driven at 250 r.p.m. from the engine crankshafts. All the running gear of the engines is enclosed, efficient splash plates preventing oil from being thrown around.

Engines and Generators

The engine flywheels, one of which is well shown in Fig. 3, are 12 feet in diameter and weigh about 12 tons. They are provided with holes for barring the engines round when overhauling. Fig. 4 is a set of indicator cards taken from one of the engines when running under test, it shows about 400 i.h.p. All the high pressure steam lines in the plant are covered with 85 per cent. magnesia 2 ins. thick, while the low pressure lines have a similar covering 1 in. thick.

Two marble gauge boards are provided, the large one carrying all pressures except steam and exhaust, and the smaller one carrying the live and exhaust steam in connection with the Corliss engines. The gauges are 12 ins. in diameter measured over the dials and are easily read at a distance. They were supplied by the Hohman & Maurer Co. The generators are 1314 ampere 110-220 volt machines built by the Canadian General Electric Co., and are built on the Dobrowsky system. They are capable of carrying a load 25 per cent. cut of balance, and can also carry a 25 per cent. overload for four hours. A commutator with carbon brushes is provided, also two slip rings. The latter have two laminated copper brushes each, which lead to a choke coil; to the middle terminal of the coil is attached the neutral of the three wire system. The choke coil is immersed in oil in cast iron tanks located behind the switchboard. The tanks are provided with radiation fins.

Switchboard

The switch board is well shown in Fig. 5. It has 13 panels two of which are to the left of the illustration and are not visible. The board is of grey marble and presents a very neat appearance. The two generator panels are shown to the left and carry connecting switches and 1600 amp. "ITE" circuit breakers by the Cutter Co. of Philadelphia, Pa., having a tripping range of from 1200 to 2400 amps. At the top of the panels are two Western station ammeters. Voltage regulating rheostats are mounted on the back of the panels with the regularity wheels in front. One main distribution panel is provided serving both the power and lighting load. It is equipped with two Thompson watt-hour meters by the General Electric Co. The clock shown above these meters is, in common with all other clocks in the stores, electrically controlled from a master clock located in the assistant manager's office.

The average winter load consists of 8,000 k.w. hours for power uses, and 12,000 k.w. hours for light, per week. The summer lighting load is, of course, much lower. As no electricity is bought, the stores are entirely dependent on this plant. The remaining panels on the board are for subdividing the distribution. The switches are all by the A. R. Coutts Co. of Vancouver. All the distributing circuits are protected by fuses which are located behind the board, where ample space has been left to get at any wiring. The distribution from the switch board is all carried in metallic conduit. A long rubber insulating mat is provided in front of the switch board, into the pattern of which is worked the firm's name. On a swing panel to the left of the switch-board are located the volt meters. They are arranged so that

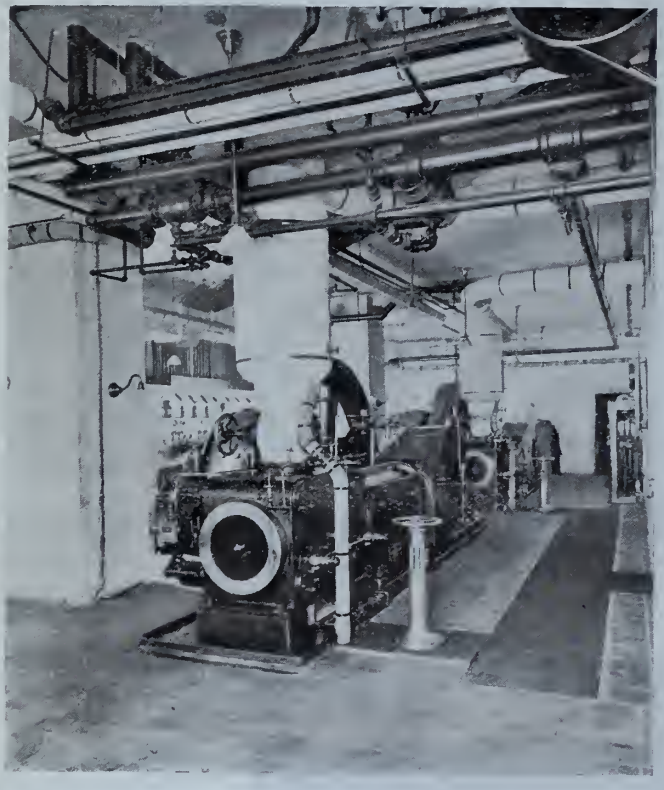


FIG. 2. END VIEW ALONG ENGINE ROOM.

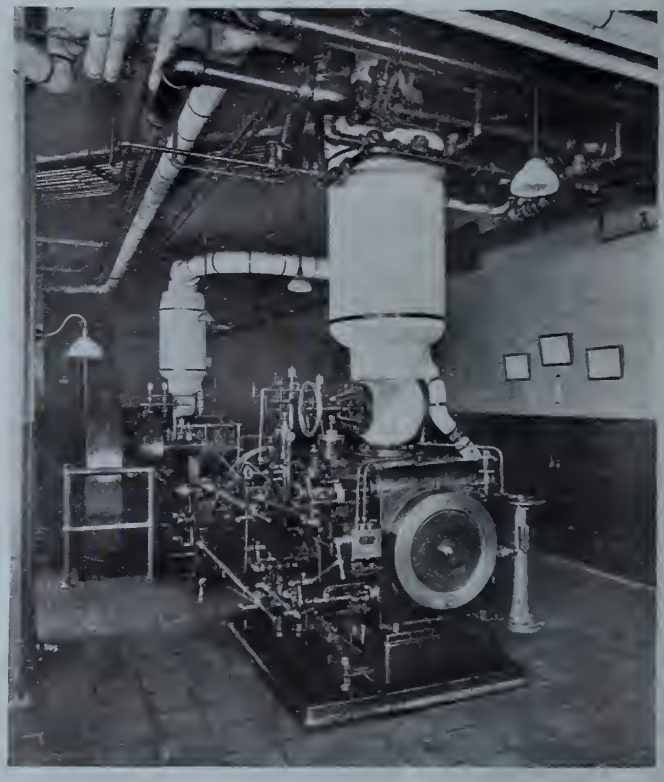


FIG. 3. GOLDIE & McCULLOCH 19 IN. X 30 IN. CORLISS ENGINE.

they can be swung round in order to be seen from any part of the engine room.

For operating signals and other apparatus requiring low tension "juice," a storage battery is provided. The bat-

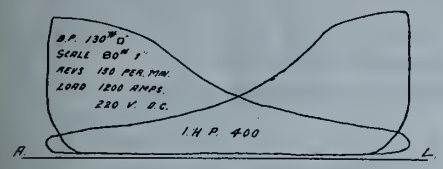


FIG. 4. INDICATOR CARD, 19 IN. X 30 IN. GOLDIE & McCULLOCH CORLISS ENGINE.

tery is charged by a pair of motor-generator sets, taking current at 110 volts, and delivering it at 24 volts. The sets are by the Canadian General Electric Co. and are mounted on a common bed. The shafts are connected by a leather link coupling.

A four tank Bowser oil cabinet is provided for the engine room, each tank of which holds 54 gallons. The tanks are equipped with measuring pumps which can be easily adjusted to deliver ½ pints, pints, or quarts of oil. The pumps are so located that overflow, if any, drains back into the tank. Other useful auxiliaries are a pair of Edison recording steam gauges, one for steam and one for exhaust; a pressure gauge tester by the Ashcroft Mfg. Co.; Crosby steam engine indicator and a Thompson ammonia indicator are also provided, the latter for use with the ammonia compressor.

The main and lower floors are heated and ventilated by warm air, but, above the main floor, the heating is done by direct radiation, using exhaust steam. In the ventilating system, dust is eliminated by drawing the air through water sprays. Two Sirocco air washers using city water are provided. There are four Sturtevant ventilating fans each direct connected to a 12 h.p. 245 r.p.m. Westinghouse motor. The fans have a capacity sufficient to completely change the air in the buildings every fifteen minutes. A temperature indicator by the Taylor Instrument Co. is provided and located in the engine room. From it the temperature of any part of the building, or that of the outside air can be ascertained by closing a switch.

A Blaisdell vacuum cleaning system is installed, the pump being 14 ins. x 10 ins. It is belt driven by a 15 h.p. variable speed motor. The pump and motor are on a common bed plate, and the short belt drive is provided with an idler which ensures good belt contact at the motor pulley. The pump suction valves are mechanically operated by an eccentric on the crank shaft, while the discharge valves are automatic.

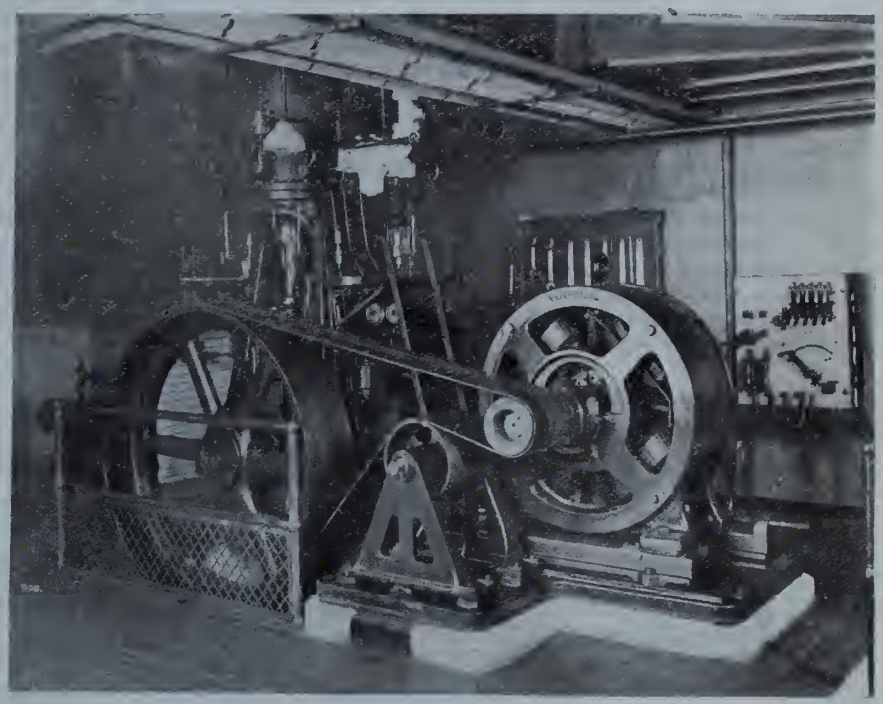


FIG. 6. REFRIGERATION EQUIPMENT DETAIL.

FIG. 5. MAIN SWITCHBOARD SHOWING INSTRUMENTS AND OPERATING EQUIPMENT.

Refrigerating Equipment

To provide refrigeration for various purposes in the stores, a 20 ton ammonia compressor is installed. It was supplied by the Frick Co., of Waynesboro, Pa. The compressor is a vertical twin cylinder, single acting machine 9½ ins. x 10 ins. and is driven about 55 r.p.m. by a variable speed Westinghouse motor. The motor has a speed range of from 450 to 900 r.p.m. It is mounted on a sliding base on the common bed plate. The compressor and motor are well shown in Fig. 6. The driving belt is of leather and is of "Duxback" brand.

A noteworthy feature shown in Fig. 6 is the spanner rack. These racks are provided near each machine and all special tools for that machine are kept in them. A glance shows if any are missing and there is no time lost looking for tools when they are wanted.

The ammonia is condensed in a double pipe condenser, the fittings of which were also supplied by the Frick Co. The condenser is shown to the left, on Fig. 7. It is supported on three solid piers. The space between one pair of piers is used to house the ammonia storage cylinder. The refrigeration is carried out on the cold brine principle. The evaporating of the ammonia taking place in a Carbondale Brine Cooler, shown in the centre distance of Fig. 7. The wood legged tank to the right is the brine storage. The cold brine is circulated by a pair of 2 ins. two stage centrifugal pumps having a capacity of 75 gallons per

minute against a head of 138 feet. The pumps were made by the Union Steam Pump Co. and are direct connected to 10 horse power, 1700 r.p.m. Westinghouse motors. The brine pipes are very heavily insulated with cork. The thickness of the insulation can be judged from the apparent size of the pipes in front of the Carbondale brine cooler.

On top of the building there are two 20,000 gallon tanks, one for the sprinkler system and the other for domestic uses, toilets, etc. All overflow water is sent up to these tanks by two motor driven three stage centrifugal pumps built by the Byron Jackson Co. One of these pumps is shown on the extreme right in Fig. 7. Each pump has a capacity of 100 gallons per minute against a head of 220 feet. The pumps and motors are on a common bed and the shafts are connected by a leather link flexible coupling. The motors are 15 h.p. and turn up 1800 r.p.m.

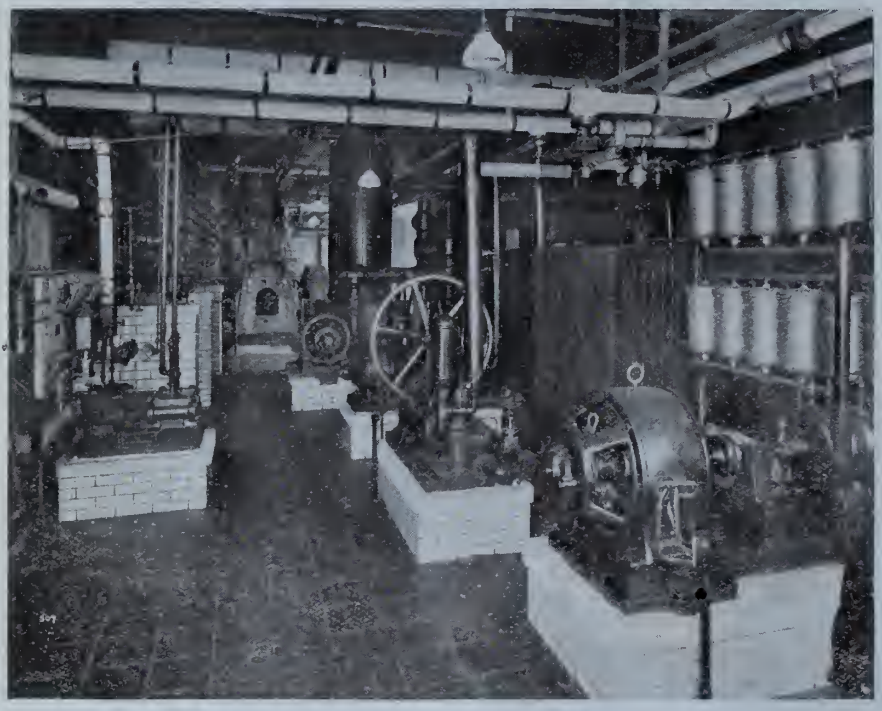


FIG. 7. PUMP ROOM, SHOWING EQUIPMENT DETAIL.

The Grinnell sprinkler system is installed in the old building, while the addition is fitted up with the International system. In addition to the sprinklers a number of hydrants are provided for fire protection. Extra pressure is provided for the hydrant lines by a four stage Byron Jackson centrifugal pump which is capable of delivering 500 gallons per minute against a 200 foot head. The pump is driven by a 50 h.p. Westinghouse motor turning up 1400 r.p,m, The motor is provided with a sheet steel cover to keep it dry in case of fire when water would probably be coming down from the floors above.

The store is provided with a pneumatic cash transfer system. This system is operated by means of two Connersville blowers having a capacity of 17 cu. ft. per revolution. The blowers are belt driven at 120 r.p.m. from 15 horse power, 1100 r.p.m. motors. The suction and exhaust pipes in connection with the blowers are of sheet steel 14 ins. in diameter. Compressed air is used for intensifying the pressure on the sprinkler system storage tank, and also for operating elevator doors, etc. It is supplied by a pair of automatically operated compressors, each rated at 50 cu. ft. of free air per minute. The compressors, twin cylinder single acting machines, were built by the Westinghouse Traction Brake Co., and are motor driven. The motors are 12 h.p., and are built into the machines with a gear drive, making a very compact outfit. The motor speed is 1100 r.p.m. which is reduced to 183 r.p.m. at the crank shafts..

Burke Horwood & White were the architects in charge of the building, while P. R. Moses of New York was the consulting engineer. The power plant is in charge of W. L. Vaughan who is assisted by S. A. Conrad and J. E. Wilson.

COMBUSTION IN HAND-FIRED FURNACES

THE fuel in most types of furnaces acts primarily as a gas producer. With a 6-inch fuel bed the oxygen in the air rising through the grate is all used up in combustion in the first 4 inches from the grate. At a distance of 4 inches from the grate the carbon dioxide content of the gases has reached or passed a maximum of 10 to 16 per cent. and begins to drop. At the surface of the fuel bed the gases contain no oxygen, only 6 to 8 per cent. of carbon dioxide and 20 to 32 per cent. of combustible gases. The composition of the gases is practically independent of the rate of air supply. The larger the quantity of air forced through the fuel bed, the faster the fuel burns or gasifies, but the ratio between weight of air supplied and weight of fuel burned remains constant at about 7 to 1. In general the temperature in the fuel bed is the highest at 3 to 5 inches from the grate, which is also the point of maximum carbon dioxide content.

Fuel Bed Thickness

As most of the oxygen is consumed in the first 4 inches of the fuel bed, it is not necessary with the ordinary rates of combustion to run a fuel bed thicker than 4 to 6 inches in order to obtain a high carbon dioxide and a low oxygen content in the flue gases. The rate of combustion or gasification of coal depends on the amount of air that can be passed through the fuel bed. The thicker the fuel bed the higher is its resistance to flow of air through it and the less air can be passed through with a given chimney draft. A thick fuel bed, therefore, reduces the rate of combustion and thus reduces the capacity of the boiler.

A thick fuel bed is further undesirable because it increases the tendency of the coal to form troublesome clinker. Perhaps the only apparently defendable excuse for carrying a thick fuel bed is the fact that the chances of burning holes in the fuel bed are reduced. A skillful fireman avoids holes in the fuel bed by firing frequently and placing coal on the thin spots. A claim that fuel beds can not be kept in good condition if carried thin is a confession of neglect and lack of skill. A fuel bed is understood to be only the layer of incandescent and freshly fired fuel and does not include the layer of dead ashes and clinker on the grate. The ask fuses in the upper layers of the fuel bed, and as it sinks it solidifies 2 to 4 inches from the grate. In most cases the fusion occurs in a reducing or partly reducing atmosphere, consequently in studying fusibility of ash the determinations should be made in a partly reducing atmosphere.

As at the surface of the fuel bed the gases contain 20 to 32 per cent. combustile gas and practically no free oxygen, to obtain complete combustion additional air must be introduced over the fuel bed. This statement is true of all the fuels, including coke, tested by the Bureau of Mines, Washington. D.C. As a general statement, about one-half of the 15 pounds of air used to burn 1 pound of coal in a boiler furnace is supplied through the fuel bed; the other half must be supplied over the fuel bed.

Combustion of coal is a chemical combination of the combustible ingredients of the coal with the oxygen of the air. The chief combustible ingredients of coal of economic importance are carbon and hydrogen in various combinations. Average commercial coal contains about 82 per cent. of carbon. and about 4 per cent. of hydrogen available for combustion. Air, without which the coal could not burn, contains approximately 20 per cent. of oxygen and 80 per cent. of nitrogen.

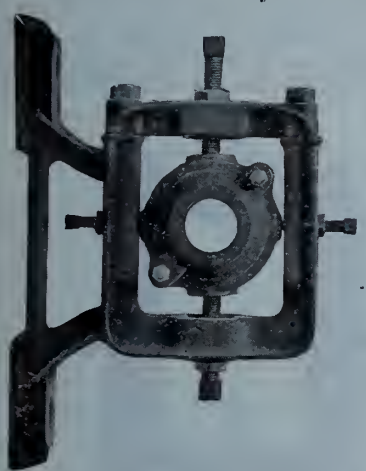
Power Transmission Section

SAVINGES MADE POSSIBLE BY BALL BEARING HANGERS

By C. T. R.

EXHAUSTIVE tests in manufacturing plants have demonstrated tbat transmission losses due to friction of plain bearings amount to from 20 to 40 per cent. of the total power used in tbe plant. The purpose of this article is to show how the major portion of this loss can be eliminated by the use of self-aligning ball bearings.

Shafts in cast iron, babbitt or bronze bearings become "set" if tbe shafting is idle for any length of time. Tbe oil is pressed out of these bearings, and it is extremely difficult to start the shaft from rest. Again, when the bearings are operating at normal speed, rubbing friction is constantly consuming



BALL-BEARING POST HANGER.

power at a sacrifice of efficiency. Self-aligning ball bearings are designed to eliminate all these difficulties.

In self-aligning ball bearings tbe starting friction is no greater than tbe running friction. This is a very important fact, for, as it is not necessary to provide for heavier starting loads, a much smaller motor may be used. Again, the rolling friction is practically uniform from rest up to very higb speed. On this account they start with a minimum effort, and operate at all times with the highest possible efficiency.

When hangers are equipped with self-aligning ball bearings, the selection of a motor for shop drives reduces itself to the problem of providing for normal machine power consumption only, without the necessity of providing for tbe heavy overload capacity usually required to "start up." For example: if machines in the shop normally require 250 horse-power to drive, and an additional 50 horse-power is consumed by the line shaft in distributing this power, a sav-

BALL-BEARING PILLOW BLOCK.

ing of 50 per cent. of the power required for tbe line shaft will reduce the total power required by 25 horse-power, i.e., 10 per cent. of the total. With a motor costing approximately $9 per horse-power, there will be an initial saving of approximately $225 in the motor cost.

So far, we have considered only the saving in power and the consequent lower first cost of the driving motor. In addition to the saving in power, which alone is a sufficient item, there is also a considerable saving in lubricant. It is necessary to lubricate double row, self-aligning ball bearings only three or four times a year. The lubricant supplied to each bearing at such times is considerably less than is generally sup-

SECTIONAL VIEW, BEARING IN HOUSING.

plied a babbitt bearing several times a month.

This economy in lubrication results from the fact that the liberal lubricant chamber around the bearing is sealed on both sides to insure the retention of the lubricant, as well as to protect tbe bearings from intrusion of shop dust, grit, etc. The seal is such tbat the lubricant cannot leak out or creep along tbe shaft to the pulleys and belts, a feature wbich preserves the efficiency of the belts and eliminates the uncleanliness and annoyance of oil.

In plants where the transmission is exposed to dust, moisture and grit, self-aligning ball bearings will give the best of service. The dust-proof housing is oil tight, excludes foreign matter and holds the lubricant. Cement mills, foundries, woodworking shops and machine shops are some of the places where htse bearings can be used to good advantage. Most shafting in plain babbitt bearings is run at speeds from 100 to 400 r.p.m., and if run at higher speeds, it is necessary to lubricate the bearings frequently to avoid hot boxes.

Self-aligning ball bearings may safely be run at double or triple this speed,

BALL-BEARING DROP HANGER.

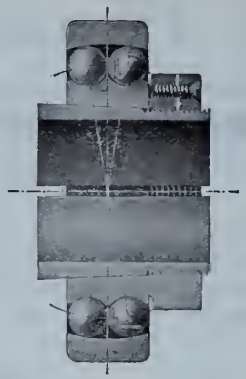
the size of the pulleys being cut down as formerly. A considerable saving in the cost of pulleys can thus be effected; or, when operating at increased shaft speed, by keeping the main line pulleys close to their former diameter (thereby increasing the rim speed), narrower and lighter belts can be used. Working along these lines, it is possible to effect savings which will equal the difference in cost between self-aligning ball hangers. Thus, it is possible to secure the highly efficient ball bearing equipment at the same initial cost as the plain bearing equipment.

Instances are frequently encountered where a manufacturer is using all his available power and is even operating his engines and boilers or motors at a

heavy overload. He constantly faces a complete breakdown of his plant. In order to add more machinery it will be necessary for him to invest considerable money in an extension of his power-generating equipment. However, by using self-aligning ball bearings this would be unnecessary in many cases, while in others, the additional requirement would be on a much reduced scale.

We are indebted to the S. K. F. Ball Bearing Co., Toronto, for the accompanying illustrations.

ADAPTER BEARING, DISASSEMBLED AND ASSEMBLED.



SECTIONAL VIEW, ADAPTER BEARING.

FRICTION AND LUBRICATION OF SHAFTING

Vulcan Staff Article.

MACHINERY and shafting in general, including the fittings, principally comprises details which are in sliding contact with each other. If clean metallic surfaces are placed in absolute contact, and one part slid over the other, excessive friction is developed, by which serious resistance to motion is caused, and the surfaces are wasted by abrasion. In order to minimize frictional resistance and to prevent wear (or to reduce this to a negligible amount), the use of a lubricant is adopted in such a manner as to effect a definite separation between the surfaces, although, at a glance, they appear to be in contact with each other. The lubricating agents commonly adopted are oil or grease in various forms and conditions; also soap, tar, and other fluid, semi-fluid and more solid substances.

Lubricant Action

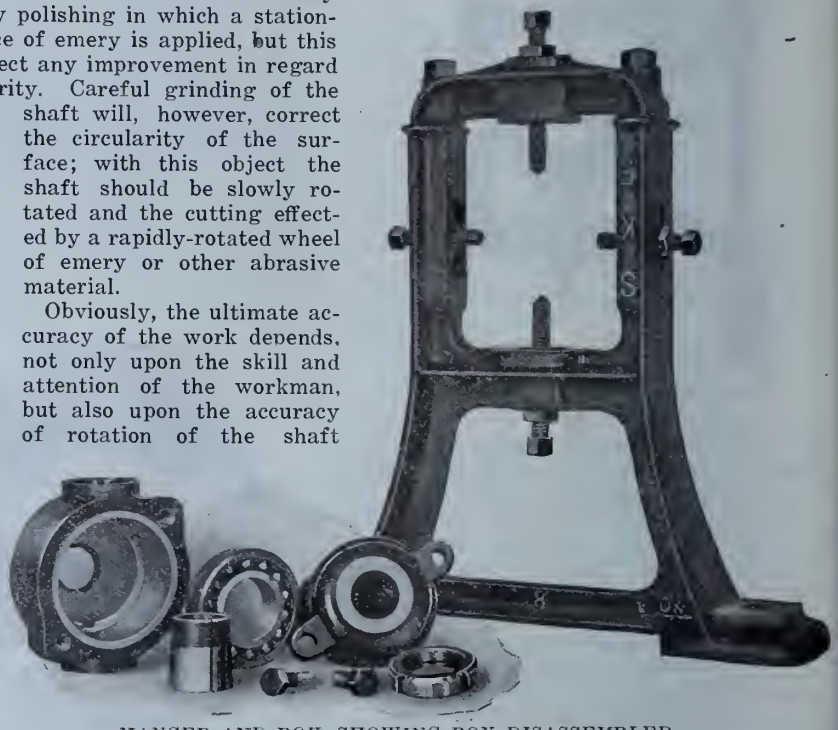
The film of lubricant acts in much the same way as a series of infinitely small friction rollers. Obviously the accuracy of action, and, therefore, the efficiency of the result, must depend upon the perfect accuracy of the fitting of the mechanical surfaces in each particular case. In connection with a shaft rotating at a high speed, the two surfaces, convex and concave, must be true to circular form. In practice a plain shaft, as left by the turning tool, is not necessarily circular in cross-section, for various reasons connected with the operation of turning in the lathe. Such a shaft is invariably finished by polishing in which a stationary surface of emery is applied, but this cannot effect any improvement in regard to circularity. Careful grinding of the shaft will, however, correct the circularity of the surface; with this object the shaft should be slowly rotated and the cutting effected by a rapidly-rotated wheel of emery or other abrasive material.

Obviously, the ultimate accuracy of the work depends, not only upon the skill and attention of the workman, but also upon the accuracy of rotation of the shaft (preferably upon hardened and ground centres), and upon the truth of rotation and freedom from vibration in connection with the revolving grinding wheel. The matrix or bearing surface by which the shaft is supported should also present an accurate surface, and where the matrix is of hard material it is necessary to adopt measures corresponding to those applying to the shaft. If, however, bearings of soft white metal are adopted, the surfaces of these will adjust themselves by wear in a comparatively short time. When the operation of correcting the circularity by grinding is properly conducted, it incidentally removes a thin coating of metal, which may be said to have been loosened or adversely affected in the principal process of turning. This metal may be compared to an infinitely minute coating of valvet, the minute fibres of which are all bent away in the same direction. By the process of grinding, a superior surface of solid metal is presented whereby the frictional resistance to motion is reduced and the vibration or deflection of the centre line of rotation is eliminated.

Ground Bearings for High Speed

All bearings which are required to rotate at a high speed should be finished by grinding, as a point of necessity. The amount of advantage to be thus obtained in connection with parts which rotate at a low speed may be correspondingly small; but in all cases, great care should be devoted to an adequate degree of accuracy in the bearings. The bearings of a crank shaft, even if working at a low speed, are of sufficient importance to call for finishing by accurate grinding in all cases in which the contractor possesses the necessary appliances. In the absence of such appliances, the shaft is finished by turning and polishing, and some engineers are strongly of opinion that better results are obtained when these operations are performed with a shaft rotating in the same direction as it will rotate in its ultimate working position. This can only be explained on the assumption that the incipient fibres of metal are pressed aside by a tool, and

ADAPTER BEARING, DEFLECTED VIEW.



HANGER AND BOX, SHOWING BOX DISASSEMBLED.

left somewhat in the manner of a pile on a velvet cloth, as above referred to. Consideration of the foregoing points will assist in the study of any question affecting the resistance to rotative movement in shafting. The same may be extended to movements of surfaces of revolution of any kind, and also to plane surfaces.

Direct Frictional Resistance

The amount of direct frictional resistance in pairs of solid bodies, as developed when one object is laid upon the other and slid along it, is proportionate to the magnitude of the force by which the one is pressed or held against the other. In the case of dry unlubricated surfaces, the frictional resistance is about one-fifth of such weight or force. This quantity is generally given in the form of a fraction, as .20, which is applied to the amount of pressure at right angles to the surface. This fraction is termed a coefficient of friction, and it is largely reduced by the use of a lubricating agent. For all metallic surfaces, plain or revolving, and which are lubricated by anointing with tallow, lard, or olive oil before placing in contact, the coefficient of friction has been found to be from 0.07 to 0.08. In good modern practice, the majority of revolving and sliding surfaces are lubricated with a copious supply of thin oil, whereby the coefficient of friction is reduced to its lowest limits. About the year 1884, B. Tower made a large number of experiments in which the coefficient was brought down to 0.001 or 0.002, equivalent to a fifty-fold reduction upon the results above given.

Types of Shafting Lubrication

The two principal types of shafting lubrication now adopted are by pump supply and by rings. In pump supply, means are adopted for the collection of oil which leaves the bearing, also to conduct it to a pump for return to the bearing so that the oil is used over and over again indefinitely. In the simple case the used oil may be collected in the bottom of a wall box, or equivalent position. This should be effected with due regard to the following points:—

(1)—The collection should be complete without leakage or distribution by spray or otherwise. Most frequently some loss is incurred by faulty fitting or arrangement. This loss is objectionable from an economical point of view. In a closely-proportioned detail, it may involve the exhaustion of the supply of oil whereby risk of heating and serious damage may be involved. Oil which thus escapes is very likely to cause damage to walls and foundations, and almost certainly it presents a most objectionable eyesore.

(2)—The means of collection and pipes by which the oil is conducted to the pump should be so arranged as to avoid deterioration of oil by dust from the atmosphere. Dust from the atmosphere may be excluded by the adoption of screens of sheet steel, well fitted against both sides of the wall box, and such other openings as may exist. These must be arranged for convenience of opening or taking apart whenever required.

(3)—It is an advantage to have a short break in the delivery pipe by which the current of oil can be placed under observation at any time. For this purpose it may very well be protected by a glass tube. This gives an opportunity for observing the quantity of oil delivered, and its condition with reference to clearness and limpidity.

(4)—The collectors should be thoroughly cleaned by scraping and brushing down to the bare iron, so that all surfaces with which the oil can come in contact are clean; also this operation should be extended to any upper surfaces from which foreign matter can possibly drop. This applies more particularly to sand, which, although it may be comparatively soft and easily removed, is often allowed to remain. The same observation, however, applies to hard sand, as this is liable to soften by extended contact with oil, and, moreover, it is at all times liable to detachment by a blow with very serious results.

Ring Oiling

Ring oiling is effected by the use of a ring or endless chain of greater diameter than the bearing. The top brass and the cap of the bearing are arranged so that the rings can lie upon the revolving shaft, and can be driven by frictional contact when the shaft is rotated. The whole arrangement, including the bottom shaft, must be so designed as to allow the ring or chain to be rove along the shaft into its position; or alternatively, the ring or chain may be arranged for division into two parts for placing in position or removing therefrom. The bottom brass is sometimes divided into two to clear the ring, but this is not necessary or desirable. The ring or chain must possess sufficient weight to originate an amount of friction sufficient to drive the ring with its load of adherent oil, and also to overcome the resistance of oil in the oil well. The oil well should provide sufficient depth of oil to load the ring without dipping so deeply as to pick up the dregs of oil. In connection with this type of apparatus, the necessity for removal of dirt, sand, and foreign matter generally, as already explained, applies to the fullest possible extent. The cap of each bearing should be so arranged as to give a good view of the oil when passing over the top of the bearing. Here also the view is necessary for estimating the quantity and condition of oil.

A certain amount of cloudiness develops in oil after repeated use. This is principally due to wear of surfaces, but its quantity should be negligible except as to a short period after starting up new work. The amount, of course, depends principally upon the degree of excellence in the fitting and adjustment of bearings whereby the amount of frictional resistance is minimized. Oxidation by atmospheric influence should be kept in mind, although it does not frequently occur with the use of good oil; but, on the whole, it is better to avoid exposure of any considerable amount of oil surface to the air.

Choice of Lubricating Oil

In the choice of lubricating oil, one of the most important conditions is the degree of completeness with which the frictional resistance is eliminated by the use of the oil. As a rule, oil which is supplied for lubricating purposes is not of a character which is prone to oxidation, but an occasional consignment may give much trouble by gumming, which arises in this way. Excessive frictional resistance is often due to excessive viscosity in the oil, which is equivalent to a deficiency in the degree of fluidity most appropriate to the work of the particular bearings in question, and chiefly with regard to the pressure per square inch to which the bearings are exposed and to the surface speed adopted. A heavy load requires an oil of high viscosity. High speed may facilitate the use of thin oil, and thereby effect a reduction in frictional resistance, but any deficiency in the workmanship is attended with greater trouble in case of the high speed.

Cases have been recorded in which a change of oil has been attended with an increase of 15 to 20 per cent. in the amount of power which is required to drive a given quantity of machinery. If the engine happens to be very closely proportioned to its work, the steam and fuel consumption will rise in a proportion distinctly greater than the increase in the horse power. Obviously, if the additional power is confined to the shafting it may be disclosed in the most striking manner by the indication of the friction load, with all machinery stopped. It is, however, improbable that an increase in the power of the amount stated can be incurred on shafting alone, but there is every reason to believe that it is often incurred in connection with the total load, on account of machinery with the hundreds of thousands of spindles which are used in textile mills.

Power in excess, which is above referred to, is in every case represented by heat which is generated in strictly accurate proportion to the amount of power consumed, and such heat is distributed over the details in proximity to the surface upon which the resistance is developed. Therefore, careful observation by touching the bearings will, in many cases, suffice to show a distinct difference between the moderate heating due to ordinary work, and the excessive heat due to inordinate resistance to motion in bearings, spindles, and other surfaces which are subject to friction.

Excessive resistance is, moreover, often caused by defective alignment of bearings, either originally or as consequent upon subsidence in the ground and foundations. Such variations in alignment may be found either in a horizontal or a vertical direction. Experience appears to show that few large works have the bearings accurately adjusted either as to lines or levels. In this connection a hypothetical example may be taken in a shaft of 4 in. diameter, which is carried in bearings placed at 10 ft.

centres, and which is deflected by ¼ in. from the accurate line in the middle of a length of 20 ft. This bearing will have an additional load of 394 lbs. imposed upon it by the deflection, and a further counter-load of 394 lbs., which latter is principally upon the two bearings next adjoining the one in principal question, or a total abnormal pressure across the shaft of 788 lbs.

At a speed of 200 revolutions, and with the full coefficient of .075 as appertaining to bearings which are occasionally oiled by manual attention, the loss by abnormal friction becomes serious, amounting to .375 horse-power. This loss is, however, very frequently exceeded by reason of the stiffness corresponding to the shafts of larger diameter, and also by reason of greater derangement of centres. In a recent case, a serious error of this kind was discovered in the second motion shaft of a large engine, as to which evidence shows that the derangement had existed and caused much trouble during many years.

Erection and Correction of Shafting Bearings

In connection with the erection and the subsequent correction of the bearings of shafting, the first point is in regard to the alignment in ground plan, as to which any fair mechanic will have no difficulty in stringing a line along beneath the shaft and straddling the shaft with a plumb-line on each side of the shaft near to each bearing. The levelling of the shafting is attended with more difficulty than the horizontal alignment, on account of the fact that special levelling apparatus is required. Ordinary levelling from one bearing to another by an ordinary straight-edge and with a hand-level is attended with difficulty and loss of much time, and is, moreover, not reliable in its results.

The majority of careful millwrights when engaged upon levelling over long distances use a water level, the principal elements in which are a long flexible tube and a terminal piece at each end in the form of a glass tube. The apparatus is filled up with water so that the surface shows in both tubes at the same level. This apparatus is very clumsy for use in most favorable conditions. It is difficult to ensure accurate transference of levels from the surface of the water in the tubes to the actual bearings of the shaft, and it is most essential that all possibility of air locks, bubbles, or other interruptions in continuity of water in the tube and connections should be fully assured.

In all ordinary cases, the use of an ordinary dumpy level, as used in survey work and heavy engineering construction, gives, however, much better results, and in a more convenient manner than any water level. In the majority of dumpy levels, the cross lines are given by thin spider webs, which are difficult to adjust in position and are liable to frequent fracture. The writer calls to mind one case, in a work of importance, in which the cross line was carried away by a strong gleam of sunshine and the work consequently stopped, causing great inconvenience. Experience of this kind will account for the reluctance of millwrights in adopting the use of such a level. In good modern instruments, however, the cross lines are given by ruling upon a glass plate, which is beyond comparison more reliable. The use of a dumpy level for this purpose is generally conducted by giving a mark for each bearing, all such marks being accurately placed at the same level. The quantity of shafting and bearings is usually much greater in a weaving shed than in other situations, but the shafting in such positions is, however, more flexible on account of its comparatively small diameter. Very great improvements have been effected by correcting the shafting on results obtained in this way.

VALUE OF INSTRUMENTS IN POWER PLANTS

INSTRUMENTS to show whether a plant is operated efficiently are generally wanting. In boiler rooms from 10 to 20 per cent. of the fuel, and more in some of them, is wasted chiefly from lack of indicating devices to detect losses. Every boiler should have a draft gauge and, if possible, a steam-flow meter. No boiler room should be without some form of gas-analysis instrument and flue-gas thermometer or pyrometer. Too much guessing is done in the average power plant, which is, in part, responsible for the miserable results obtained. Few plants pay particular attention to obtaining economic combustion; many operators have no idea what high CO_2, low CO, and other such expressions mean. Hence it is not surprising that there are boilers operated at 40 per cent. efficiency.

An automatic CO_2 recorder has a great moral effect upon the fireman, and numerous boiler plants can thank this apparatus for a large saving in fuel consumption. While it is of great value in any boiler plant, plants having a variable load with hand-fired boilers, and those having chain grates, stokers, etc., especially need this apparatus, since in them CO_2, ordinarily, is found the lowest.

The steam-flow meter on each boiler in connection with proper interpretation of the pressure through boiler gas passages, is also of great value and, with intelligent, trained men in charge, even preferred to the CO_2 recorder.

The common differential draft gauge is also importnt, for, when properly connected, it will tell whether the boiler is being operated at, below, or above rating; and whether the fuel bed is too thick, or dirty, or full or air holes. The draft readings must, however, be intelligently interpreted, and they seldom are. Fed operating engineers know the real value of the draft gauge.

Flow meters are quite important in testing recipracating pumps for their displacement efficiency, and centrifugal pumps for decrease of efficiency from wear of internal parts. When a plant is installed, provision should be made in various steam, water, and air lines for connecting a flow meter, and if none is put up permanently, a test meter should be kept to check the performance of various departments or single units of power machinery and the keeping up of

$$\text{the } \frac{\text{output}}{\text{input}} \text{ ratio.}$$

PROPER FEED WATER

MUCH heat is wasted by dirty boilers, and the cost of cleaning in most plants is considerable. Using distilled water as boiler feed should be advocated whenever possible. In large plants the condensate from the condensers of the main units could be used to condense the exhaust steam from the auxiliaries, and all the make-up water obtained from a cultiple-effect evaporating system, or flue-gas evaporators working under vacuum. In other plants more attention should be paid to treating the feed water.

Properly treated feed water will not only improve the efficiency of a boiler as a heat absorber, reduce the cost of boiler cleaning and its repairs and increase its life, but will also greatly increase its safety, since most boiler explosions and accidents can be traced to unsuitable boiler feed water.

City boiler inspection departments, with the aid of water departments, could be of great aid to the operating engineers in the particular cities by keeping them informed as to what treatment the water requires to make it suitable for boiler feed. Much good could also be done by boiler insurance companies, not only to the engineers and power plant owners, but also to themselves, if they had chemists to inspect samples of feed water and advise proper treatment.

EXPLOSIONS IN BOILER FURNACES

AS the gases rising from the fuel bed contain 20 to 32 per cent. of combustible gases, it is not difficult to understand that under the right conditions an explosive mixture can be formed that might cause an explosion violent enough to injure the fireman. An explosive mixture can be formed in a boiler furnace in either of the two following ways:

1—With a tight setting and the fire doors completely shut so that no air is entering above the fuel bed, the furnace and the setting are filled with a combustible gas. If then the fire doors are suddenly opened a large volume of air is admitted into the furnace and mixes rapidly with the combustible gas. Under such conditions the combustion of the gases may be so rapid that it assumes the violence of an explosion.

2—With the fire doors wide open the furnace and the setting fill with air. If then a shovelful of slacky coal is spread over the fuel bed and the fire doors are quickly closed, the large volume of combustible gas rising from the freshly fired coal forms an explosive mixture with the air in the setting. An explosion may follow which is strong enough to blow the fire door open and even lift the hood noticeably from its seat on the setting.

Observations on Safety Valves for Marine Boilers*

By E. F. Maas

The various elements of marine boiler safety valves which have to do with successful operation are considered. Seven typical valves are discussed and illustrated. Many suggestions of practical value for the grinding and repair of safety valves are embodied, these being the result of observations made by the author on valves under working conditions, and on repaired valves in the laboratory. The subject is pertinent to our shipbuilding revivals.

THE purpose of this article is not give a complete description of the design and working of all marine safety valves to be found on the market to-day, but to analyze some of the characteristics of the working parts of the more common types, to indicate their advantages and the difficulties experienced with them, and to point out helpful methods in repairing and improving old valves. The paper presents the results of observations made on valves under working conditions and during tests of repaired valves in the mechanical laboratory. In the case of one valve, not yet upon the market, the statements are based upon experience gained from work on other valves, and on a somewhat incomplete report of laboratory tests of this valve. This test was not witnessed by the author. Each of the seven figures gives, not a complete view of a valve, but a partial section only, this section showing such parts as come within the scope of the paper. It is assumed that the working of these safety valves is familiar to every reader, as well as the nomenclature of the valve parts. No general explanation of them, therefore, is given.

Fig. 1 represents a valve of a somewhat obsolete design probably not made by any manufacturer to-day. This type

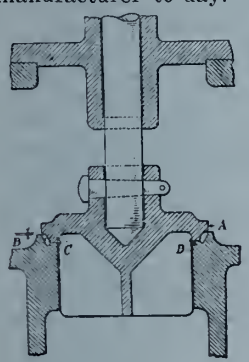


FIG. 1. OLD TYPE OF SAFETY VALVE.

is still to be found, nevertheless, in many of the older ships, and should be considered. Fig. 2 shows a later type of valve having an attachment for adjusting the blow-down, a feature indispensable in a modern marine safety valve. Fig. 3 is practically the same as Fig. 2, the main difference between the two being in the design of the blow-down adjustment. Fig. 4 represents one of the latest and most successful designs on the market at the present time. In Fig. 5 is shown a valve which has not yet fully emerged from the experimental stage, and to the knowledge of the author is not yet offered for sale as a marine safety valve. Figs. 6 and 7 show modifications made to valves of

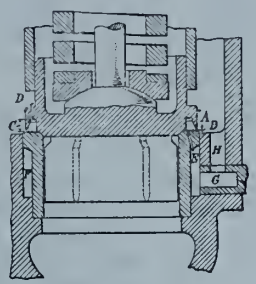


FIG. 2. LATER TYPE OF VALVE WITH ADJUSTABLE BLOW-DOWN.

the type represented by Fig. 3, these modifications having been applied during the repair of these valves in order to fit them for further service, after their original working adjustment had been destroyed through long service or neglect in maintenance. The particular features discussed in the article are:

(a)—Valve seat, flat or beveled, and its tightness.

(b)—Pop of valve, amount of simmering before pop, and height of lift.

(c)—Closure of valve and chattering at closure.

(d)—Blow-down of valve and methods of adjustment.

(e)—Discharge capacity.

(f)—Overhaul and adjustment of old valves and improvements made at slight expense.

Valve Seat

A glance at the figures will disclose two valves with flat seats (Figs. 1 and 5), the other five having beveled seats. While this might indicate that the beveled seat is the more common, the relative advantages of each type are strongly supported by manufacturers of the two types. The experience of the author has been that a flat seat is just as easy to grind-in and make tight as a beveled seat, and that the flat seat is more likely to stay tight. On account of the distortion of the valve seat which will result from a slightly uneven expansion or from spring of the material under high pressure, the tightness of a beveled seat is seriously affected, and the more so the greater the bevel, if by bevel we understand the angle between the valve seat and a plane perpendicular to the center line of the valve.

On the other hand, a flat seat will remain steam-tight even after a considerable distortion has taken place, provided that the valve has been carefully ground to its seat in the first place. It should be borne in mind that the valve and seat are in contact only along a very narrow strip, in the case of either flat or beveled seats. For equal lifts of the valves, a flat seat will give a greater discharge capacity under certain circumstances, as will be discussed later, a fact which will weigh in favor of the flat seat, for some designs, at least. It has been argued that a beveled seat, especially where the bevel is considerable, about 45 deg., will more easily rid itself of particles of scale or other foreign matter between the valve and its seat. In this connection attention should be called to the prevalent custom in marine practice of attempting to tighten the valve on its seat by turning it by means of the valve stem. Such practice usually has an effect directly opposite to that desired. A better way is to lift the valve from its seat by the easing gear and thus blow away the scale or other matter. A steeper bevel than 45 deg. is inadvisable for a steam safety valve, as the tendency for the valve to stick on its seat is too great and may produce disastrous results. It is significant that while only a few years ago most safety-valve specifications

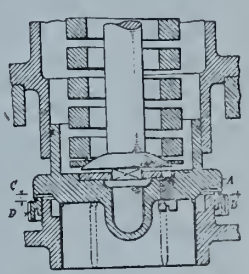


FIG. 3. MODERN SAFETY VALVE WITH ADJUSTABLE BLOW-DOWN.

called for seats beveled at an angle of 45 deg., specifications of to-day, notably those of the U. S. Navy Department and various State Boiler Rules, do not require it, indicating that a transition from 45 deg. to the flat seat seems to be under way. It is the author's opinion that such a change is for the better.

Pop of Valve

By "pop" of a safety valve is meant its instantaneous rise to almost full lift after the first tendency to move from its seat, or what is known as simmering,

*From a paper presented before the American Society of Mechanical Engineers, New York, December, 1916.

has taken place. A clean-cut pop is most vitally necessary in a successful safety valve. Without pop there will be a prolonged simmering of the valve as soon as the pressure has been reached for which the valve has been set, and the unduly prolonged simmering will soon score both valve and seat, particularly if the steam is superheated, thus producing a leaky valve. The pop of the valve in Fig. 1 will be determined by the diameter of the flange A, the amount of the distance B, and, to some extent, by the shape of the surface C. It is assumed, of course, that the valve has been ground to its seat and made tight. To design a valve of this type that will give a satisfactory pop, therefore, requires previous experience regarding the relations of these three variables, otherwise some experimenting must be done. When this valve is refaced and reground, it is also of utmost importance that the original conditions of the working parts be restored. Gauges for the original shape of both valve and seat, and the proper distance between the two, should be furnished the machinist repairing the valve, otherwise a misfit is liable to result and an uneconomical valve produced. A valve of this type requires a very long spring in order to give a satisfactory lift, on account of the small overhang of the flange A over the seating surface of the valve D, which limits the available additional lifting force required after the valve has started from its seat.

In the valve in Fig. 2, the pop will depend on the diameter of the flange A, the amount of the distance B, the depth C of the main pop chamber, and the size and number of the holes D. Of these four items, A and D are determined by the manufacturer of the valve, and, if rightly proportioned in the first place, need never be changed. Items B and C are both variable, however, with the wear and refacing of the valve and seat. In this valve it is desirable to have the lip A wear down in the same proportion as the valve and seat. As this is very seldom the case, however, there arises the necessity for adjusting these features when the valve is overhauled. It should be noted that the depth of the pop chamber does not influence the pop as much as does the distance between the flange lip and the valve bushing. The former need be checked only roughly, while the distance B must be absolutely correct. An approximate value for B is 0.01 in. for the average size of marine safety valve.

The pop in Figs. 3 and 6 is decided by the three items, size of flange A, distance B and depth of pop chamber C. In these respects the valves are similar to the valve of Fig. 2, the remarks about which will apply to Figs. 3 and 6. One difference, and an important one, is that the distance B can be adjusted after the valves are assembled, by means of the blow-down ring D. Thus, it would seem as if the necessity for the very close machining of the lip A in overhauling these valves would not exist. Such is not always the case, however, as the adjustment of the distance B for a satisfactory pop may interfere with the adjustment for the desired blow-down. This will be explained in more detail later.

In the valves of Figs. 4 and 7, the pop is dependent upon the size of the flange A, the distance between flange and

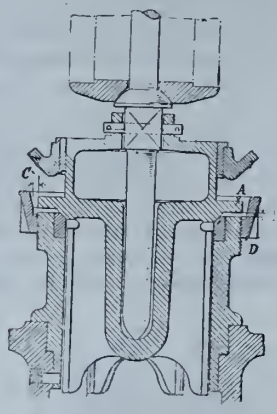


FIG. 4. RECENT TYPE OF MARINE SAFETY VALVE.

valve seat B, and the width of the ring-shaped opening at C. This difference between the two valves prevails, however, that in Fig 4 the main deciding feature is the distance B, by reason of holding the ring area C comparatively large, whereas, in Fig. 7, the pop will be determined mainly by the distance C, which is just large enough to let the valve flange A clear the inside of the adjusting ring D. Therefore, in overhauling the valve of Fig. 4, strict attention must be paid to the distance B in order to bring it back to its original value, by means of a cut from the wider side of flange A in case either the valve or its seat have been refaced, thereby lowering the valve and decreasing the distance B. In the valve of Fig. 7 only a rough check of distance B need be made. A suitable valve for this distance in an average-size valve is 3/16 in. The width of the ring area C has been fixed once in making the valve parts, and need never be changed in overhauling this valve.

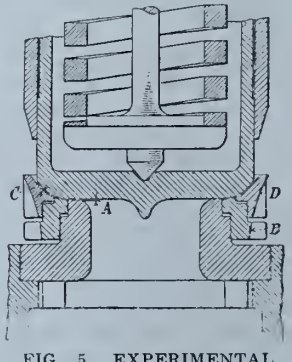


FIG. 5. EXPERIMENTAL VALVE.

In Fig. 5, the pop depends upon the distances A and C, which can be regulated by means of the adjusting rings B and D. The inner ring should be screwed very close to the valve disc, but not touching it. The outer ring furnishes the greater part of the additional lifting force required after the valve has started from its seat.

Simmering

The reduction to a minimum of the period of simmering before lift, which is very essential to the successful working of any safety valve and to the length of its useful life, can easily be accomplished in all the valves of Figs. 3 to 7 if the proper care is exercised. In the valves of Figs. 1 and 2, as previously pointed out, the reduction of the simmering is mainly a question of design and original adjustment, unalterable after the valve has been set up.

Lift

It is known that all safety valves will give their highest lift at popping, the sustained lift being less than this by from 10 to 25 per cent.. The average lift of a 3-in. or 4-in. valve is about ⅛ in. To increase this lift without interfering with the blow-down or resorting to abnormally long springs is a difficult matter. In order to obtain the maximum lift, the valve spring should be made to contain as many turns as possible within the space available for it.

Closure

In order to prolong the life of a safety valve, it is necessary that its closure be accomplished with the minimum amount of shock. When a valve comes down on its seat each time with a heavy blow, both valve and seat will soon be distorted, and the valve will start to leak. For obtaining a large discharge capacity, a high lift is desirable, but this becomes a detriment if the closure is accompanied by shock. In this respect a valve with a beveled seat is generally inferior to the one with a flat seat, as the flat seat affords more of an opportunity for the steam to form a cushion at the moment of closure. Especially is this the case with the valve shown in Fig. 5, there being an excellent steam cushion between the valve disc and the inner ring B for checking the descent of the valve. Another valve which seems to give an easy closure, although having a 45-deg. beveled seat, is the one shown in Fig. 7. It is to be regretted that on neither of these valves are there available data on the length of their useful service without repairs upon which to base a more reliable conclusion regarding this feature of the valve closure. As previously mentioned, both of these are new types of valves and not yet fully tested out in service. The tendency of a valve to chatter at closure is generally caused by too small a blow-down.

Blow-down

For adjusting the blow-down, or difference in steam pressure under the valve at popping and at closure, there are two different systems represented in the valves shown. Before analyzing these two systems, it should be mentioned that in the valve of Fig. 1 there is no adjustment of the blow-down. In this valve, therefore, the amount of blow-down desired will have to be decided on in advance, by previous experience from similar valves, proportioning the

valve flange and the spring as well as the shapes of valve and seat so as to give the desired blow-down.

The arrangement in the valve of Fig. 2 for adjusting the blow-down is one probably familiar to most steam engineers. When this valve discharges, part of the steam passes through the holes E drilled in the bushing and into the chamber F, generally termed the secondary pop chamber, but more properly called the blow-down chamber. The only exit from this chamber is through the bushing G and the passage H communicating with the discharge space of the valve casing. By turning the bushing G and locking it in different positions, the size of this exit passage for the steam can be restricted, thereby limiting the amount of steam passing through the holes E, and so regulating the pressure under the valve lip A. Of course, the holes D in the valve flange will have a similar influence on the blow-down. The size and number of these holes are generally proportioned for a minimum blow-down of, say, 4 lbs. A smaller blow-down than this should not be attempted in any safety valve as it only shortens the life of the valve and produces a tendency to chattering, as previously mentioned, with no additional advantages in the working of the valve.

In all of the valves of Figs. 3 to 7, the adjustment of the blow-down is accomplished by means of the adjusting rings D. Screwing these rings up will increase the blow-down and screwing them down decreases it. The shapes of these rings should be noticed. The rings of Figs. 4 and 5 are especially adapted to give a minimum obstruction to the flow of steam and so increase the discharge capacity of the valve, both being excellent shapes. It has been especially claimed for the ring of Fig. 5 that in conjunction with the lower ring B it has the effect of reducing the lifting force at very low lifts and increasing it as the lift increases. This is a most desirable feature in any safety valve.

The ring D of Fig. 7 has been designed and tried out as an improvement on valves of the type shown in Figs. 3 and 6. It has already been pointed out that in these valves the main feature determining the pop is the distance B, also that the position of the ring D will determine the amount of the blow-down. Thus it will be seen that there are two factors to be considered in determining the proper position of these adjusting rings, and that each of these factors may require a different setting of the ring. In such a case it is necessary to take out the valve disc and machine its lip A until the proper distance of this lip over the adjusting ring is obtained, after first determining the position of the adjusting ring for the desired blow-down. This procedure involves tedious trials.

Where gauges for finishing the valve disc and adjusting ring are furnished by the manufacturer of the valve, it is comparatively easy matter to machine these parts when making repairs. When the time comes, however, to overhaul the valve, it is generally found that all gauges are lost or unavailable. In order to eliminate the tedious machine work in overhauling and adjusting valves like those in Figs. 3 and 6, the modifications as shown in Fig. 7 were devised. The lip of the valve disc has

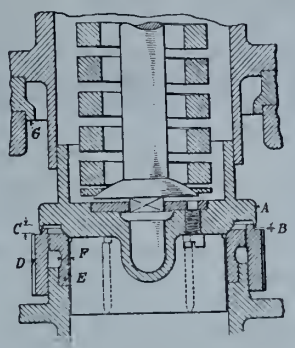


FIG. 6. MODIFIED SAFETY VALVE OF TYPE 3.

been cut away and the diameter of flange slightly reduced. The shape of the blow-down ring has been changed entirely, as shown, and made somewhat similar to the one in Fig. 4. The different action of the two rings D in Figs. 4 and 7 as regards popping has already been explained. The main feature in the ring of Fig. 7 determining the blow-down is the angle E. This angle, 36 deg., 30 min., has been found to give a range of blow-down of from 4 to 9 lbs. The laboratory tests on the popping and blow-down of this improved valve have given very good results.

Discharge Capacity

It is well known that when steam under pressure is allowed to flow through an opening, the maximum discharge will be obtained when the lower pressure is equal to or less than 58 per cent. of the higher pressure. When such conditions obtain, the pressure at the throat section, or most contracted part of the chan-

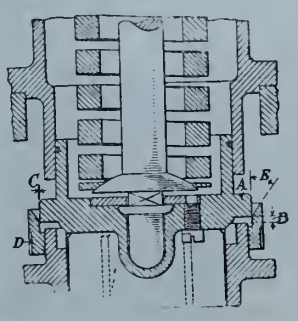


FIG. 7. ANOTHER MODIFIED VALVE OF TYPE 3.

nel through which the steam is flowing, will be 58 per cent. of the higher pressure, regardless of how much the pressure in the discharge chamber will fall below this value. The weight of steam discharged can then be calculated from Napier's formula: Flow in pounds per second = absolute pressure × area in square inches ÷ 70. If this is applied to the safety valves shown in Figs. 1 to 7, it will be found that the valves of Figs. 1, 2, 4, 5, and 7 undoubtedly will have their throat section at the inner circumference of the valve seat. Therefore, the area of opening at this section will determine the discharge capacity of the valve, provided the resistance to the flow is not made great enough to raise the pressure in the valve casing above 58 per cent. of the pressure under the valve seat. Making allowances for reductions of the free opening over the valve seat caused by guide wings, the following approximate formulæ, as given by some manufacturers, are obtained for calculating the discharge capacity:

$W = 149$ lpd for a flat seat

$W = 105$ lpd. for a 45-deg. seat

where W = discharge in pounds per hour
l = lift of valve in inches
p = absolute pressure under valve, lb. per sq. in.
d = diameter of valve seat in inches.

For equal lifts, then, the flat seat will give a greater discharge than the 45-deg. seat, which is obvious when it is considered how the 45-deg. seat restricts the throat section of the valve as compared to the flat seat. It should be mentioned here that the discharge capacity will be influenced to some extent by the smoothness of the approach to the throat section. On this account, the valve of Fig. 5 should give an exceptionally good discharge capacity, which seems to be borne out by the meagre test figures available. With valves of the shape shown in Figs. 3 and 6, it is frequently found that the actual discharge capacity will fall considerably below that obtained by the above calculations. This, no doubt, can be accounted for by the throttling of the discharge channel under the valve lips, especially at the lower lifts.

Repair and Adjustment

Bearing in mind that a safety valve, to be successful and satisfactory, must not have too delicate an adjustment nor require too frequent overhauling, it seems advisable to alter the valve in Fig. 3 to the type shown in Fig. 7, where repeated attempts at obtaining satisfactory operation of the old type have failed. Such alteration can be accomplished easily and cheaply, as the only new part to be made is the adjusting ring D, and the only part to be machined is the valve disk. The result will be an exceptionally rugged valve having no delicate parts, and one which can be easily overhauled and adjusted without expert assistance.

Grinding

For grinding a valve to its seat the most satisfactory grinding material is powdered glass and machine oil. It is easiest and most expedient to grind a valve cold, and this will in most cases produce entirely satisfactory results. Only where repeated efforts at making a valve tight by these methods have failed, should hot grinding be attempted. The hot grinding is a trying performance to any workman, and will only be an approximation to actual working conditions in any event, as a grinding at the actual temperature under which a safety

valve operates is out of the question. Where all other methods have failed to produce a tight valve, the design shown in Fig. 6 will sometimes serve. By inserting the raised seat E and taking care to machine this so that its weakest section F will be between the old valve seat and the new, there is an opportunity for this raised seat to adjust itself to the valve, regardless of what expansions and contractions may be taking place in the metal of the old valve seat. Frequently this will produce a tight valve. The construction shown in Fig. 6 is an improvement on the valve shown in Fig. 3, but the same, or a similar design, can be applied equally well to most other types. In making this alteration to a valve it is necessary to have a new valve seat E and adjusting ring D, and to insert a distance piece G under the valve bonnet in order to raise the bonnet the same amount the valve has been raised from its former seat. The author has seen this method applied frequently and with great success.

Another point, often misunderstood in repairing a safety valve, is the amount of clearance to give to the guide wings under the valve disk in the valve bore. No attempt at a very close fit of these parts should be made, as such would only increase the chances of the valve sticking. A suitable clearance for a 4½-in. valve bore is 1-32 in. on the diameter, or 1-64 in. on each side.

HEATING BY STEAM AT DIFFERENT PRESSURES

RECENTLY in Chicago tests were made to determine the relative cost of heating with steam at atmospheric pressure as against 3 to 5 lb. pressure in modern office-building plants. In an analysis of the problem a heat requirement of 5,000 B.t.u. per hour was taken. On the whole, it appears that there is no appreciable difference in cost in heating at different pressures. There is, however, an advantage in higher pressure from the standpoint of first cost of plant, because as the pressure is greater the plant may be smaller. This factor, however, has a limited value in practice unless excessive pressures are used. As a matter of fact, any plant designed to work at 5 lbs. should have margin enough to work perfectly at atmosphere, and vice versa, so that in the end the cost of heating will be identical in both cases.

Canadian Westinghouse Co. Elects Officers.—At the annual meeting of the Canadian Westinghouse Co., held at Hamilton on March 27, the following elected to the directorate of the concern: H. H. Westinghouse, Hon. Lieut.-Col. Paul J. Myler, L. A. Osborne, Thomas Ahearn, Sir John M. Gibson, K.C.M.G., John F. Miller, C. F. Sise, Warren Y. Soper, Charles A. Terry, Guy E. Tripp. The officers are: H. H. Westinghouse, chairman; Hon. Lieut.-Col. Paul J. Myler, president and treasurer; L. A. Osborne, vice-president; F. A. Merrick, vice-president and general manager; John H. Kerr, secretary; N. S. Braden, manager of sales.

ADVANTAGES OF ECONOMIZERS

BOILER plant efficiency can be considerably increased by adding economizers, which are used in most European plants, but find little favor in this country. The objections ordinarily offered are:—Their initial cost; reduction of available draft and, in many plants, necessity of installing mechanical-draft systems; cheap fuel (speaking comparatively); low load factors; complication of the power-plant outlay.

The chief reason that they are not used more generally is that their value is not realized. It is difficult to reason out just what effect load variations have upon an economizer as a heat absorber. If plants were operated continuously for 10 or 12 hours and completely shut down the rest of the time, the saving would be in proportion to the load factor, but where the load remains on, and only varies from overload to underload, the value is difficult to determine. Since however, such plants are ordinarily operated uneconomically at both high and low loads, and since economizers are of greater value the lower the boiler efficiency, they are particularly needed in plants having variable loads, and the saving in fuel, if not more, will be at least proportional to the load factor. Much depends upon properly proportioning the installation, and, therefore, before an economizer is decided upon, a plant must be closely studied and the governing factors, such as flue-gas temperature, feed-water tempperature, weight of air per pound of coal, load factor, character of load, etc., very closely predetermined.

UTILIZING EXHAUST STEAM

THE value of exhaust steam for heating and the consequent saving effected has been demonstrated, and many plants take advantage of it, but the practice should be more general. Even plants operating condensing could bleed the low-pressure receiver of a compound engine or the low-pressure stages of steam turbines and distribute this steam through the buildings. In power plants where economizers are not employed and the temperature of the water is low when fed into the boilers, this partly expanded steam could also be used to advantage in feed-water heaters.

In plants where large quantities of low-pressure steam are required and the pressure cannot be expansively reduced in a cylinder or turbine, a saving still could be made by generating this steam in a boiler under low pressure. It has been experimentally determined that there is about 6 per cent. difference in boiler efficiency between generating steam at near atmospheric pressure and at 350 degs. Fah., because of the increased temperature difference between the furnace gas and the boiler water, greater heat absorption and consequently lower flue-gas temperatures.

REDUCIBLE LOSSES IN POWER PLANTS

THE greatest and most neglected loss in the average boiler plant is from excess air. The magnitude of this loss at different CO_2 percentages is applicable to any fuel, liquid, solid, or gaseous, if its available hydrogen percentage is known. The impression prevails that coal must be burned with about 50 per cent. of excess air. Some authorities claim that going beyond 10 to 12 per cent CO_2 the loss due to incomplete combustion will offset the saving effected by reducing the excess air. This opinion is based upon certain types of installation only, and should not be accepted and disseminated as a general condition. Some few up-to-date plants are averaging 17 per cent. CO_2 with bituminous coal, without serious losses due to incomplete combustion.

One objection to high CO_2 is the extremely high furnace temperature and consequent rapid depreciation of furnace linings. For this reason many maintain 10 per cent. CO_2 as the maximum. With low percentages of excess air, proper design of combustion space becomes much more important to prevent incomplete combustion and too high furnace temperatures. Exceedingly high furnace temperatures have no real advantage and several disadvantages, therefore heating surface exposed directly to the fuel bed to reduce the furnace temperature will not only cause a decrease of the slagging effect upon the firebrick, and thus increase the CO_2 popssible to maintain, but will also increase the efficiency of the boiler due to the heat radiated directly to it, and will increase the boiler capacity without increasing the flue-gas temperature. With a proper furnace volume, smoke will not form if provisions for gas mixing are maintained and the temperature does not drop off too low or the boiler is not forced too much. Velocity of gas, time of contact, and hydraulic mean depth are important and deserve thorough study under all conditions of installation. Not much is being done in this direction and quite large boiler builders ignore the matter altogether.

Boilers can be operated at two times their rating, and more, but not economically unless designed for it; with the rates of heat absorption obtained at present in most installations, if operated at very high ratings the loss will be too great, unless the temperature of the escaping gases be reduced in economizers. The increase of velocity will cause draft loss, but this is not so serious, for the necessity of installing mechanical draft brings other advantages. With high ratings and high velocities the power required to produce the draft becomes of interest. Fear that so much of the steam generated will be required to produce the draft that the advantages obtained will be offset is unfounded, if the blower is designed for efficient work and driven by an efficient engine or motor.

Electricity and Hydraulics

OPEN CIRCUITS IN D. C. ARMATURES*

A VERY frequent form of breakdown to all direct-current armatures is that of an open circuit, which may be due to broken wires at a point close up to the commutator, and between that and the armature coils, or may be only due to a melted connection on the commutator lug. There are several causes for this defect, which may conveniently be classified as follows:—

(a)—Mechanical causes.

(b)—Electrical causes.

Considering first the mechanical side of the question, it will be found that in nearly all cases there is to some extent a slight movement between relative parts of the armature; that is to say, between the windings and commutator. Relative movement or vibration can be set up by a faulty drive or even by the rotation of the armature itself, if the machine is not securely fixed to or on a suitable foundation. Perhaps the most frequent cause of this class of breakdown is a loose key on either the commutator or the armature core, and in this connection the following example demonstrates a failure of this type.

The machine in question is of 60 horse power, and runs at a speed of 600 revolutions per minute on a 440-volt circuit. The laminated core of the armature windings is fitted direct on the shaft, and held in position by a key 13¼ ins. long by 1¼ ins. wide by ⅝ in. deep. The movement of the core on the key had apparently been taking place for some considerable time, and the wearing away of the key and also of the shaft was very considerable. Both the key and the shaft are now covered with circumferential grooves caused by the rubbing of the individual laminations of the armature core. The position of the ventilating ducts and also the alignment slot in the core remained normal. As a result of the breakdown, it was necessary to carry out the rebuilding and rewinding of the armature, including a new shaft.

Considering next the electrical causes of this type of breakdown, a machine that is run above its rated output is more liable to break down on account of the overheating of both the commutator and the conductors, which frequently reaches such a point that the solder in the commutator lugs is melted out. Also, as the commutator wears down, the current carrying capacity is thereby reduced, though at first not very appreciably. The time usually arrives, however, when the section of copper is so much reduced that overheating takes place, and the connections suffer. Machines have been known to break down repeatedly, due to melted connections caused by a commutator of restricted design, and after a new commutator of more ample proportions has been fitted, the same machine has run satisfactorily. Open circuits, broken wires, or bad joints very quickly show their presence, as the machine commences to spark violently each time the two ends of the open circuit come under the brushes, and if this is allowed to continue, the commutator is very soon burnt, and, as often occurs, requires several new sections of both copper and mica fitting.

*Article in Vulcan by a member of the staff.

CYCLE COUNTER OR TIMING DEVICE

AS IS generally known, it is not possible to obtain satisfactory results in the testing of time elements of high accuracy relays and of circuit breakers, with a stop watch, particularly where the selective action of the circuit breaker is essential. For this purpose, the Westinghouse Electric & Mfg. Co. of

CYCLE COUNTER OR TIMING DEVICE

East Pittsburgh, Pa., has developed the cycle counter illustrated, which is a device for indicating definitely the number of cycles required for the relay to close its contacts.

The mechanism of this timing device consists essentially of an electric self-winding clock, the escapement of which is operated by an alternating current oscillating magnet instead of a pendulum or balance wheel. At each cycle, one tooth of the escapement is released. The self winding clock periodically rewinds by means of power supplied from a shunt connection to the circuit when the cycle pointer has made 60 revolutions, the equivalent of 3,600 cycles. This arrangement keeps an even tension on the escapement, Thus, the escapement magnet is not depended on to drive the indicator, but simply to regulate its speed. The power for driving is furnished by the clock mechanism.

In operation the cycle counter is connected in series with the relay on a circuit adjusted to give the current value at which it is required to test the relay. When the circuit is closed, the "cycle" pointer begins to revolve, one step per cycle, and continues to do so until the contacts are closed. The instrument acts as though it had no inertia; that is, it starts the instant power is applied and stops the instant power closes.

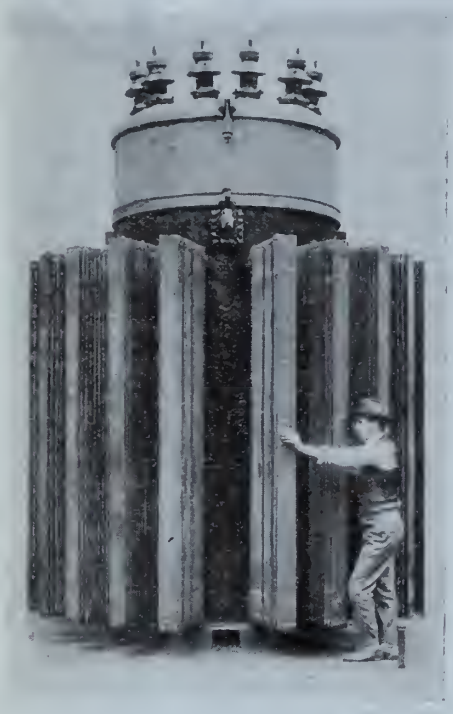
Although primarily designed for use in testing or adjusting time-element relays, this instrument is suitable for a great variety of testing. Its particular field of usefulness is for measuring elapsed time intervals of time too short to be satisfactorily observed with a stop watch and where readings in steps of one alternation are sufficiently accurate, obviating the use of complicated and expensive apparatus such as chronographs or oscillographs.

Given a known frequency the readings can be reduced to seconds if desired. Conversely, by connecting the instrument to a circuit for a definite period of time the frequency can be determined. By adding contacts to machine tools, elevator machinery, etc., the time required for various functions can be determined. It will also be found useful in many laboratories and test rooms for timing purposes.

GIGANTIC VOLTAGE REGULATOR

THE accompanying illustration shows what is claimed to be the largest piece of apparatus of its type which has ever been built. It is a self-controlled, induction feeder voltage regulator of the oil-insulated self-cooling type and was recently completed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for a large power Co., in the

Southern States. It is rated at 600 k v a., 3-phase, 60 cycles, 13,200 volts, with 10 and 20 per cent. regulation at 262 and 131 amperes, and is designed for operation out doors with full-automatic control self-contained. When installed, the regulator will be connected to the low voltage side of a 6,000 kva.



GIGANTIC VOLTAGE REGULATOR.

bank of 44,000 to 13,200 volt transformers on the power Co.'s line, and by its use the power from the line will be delivered to the consumer with the voltage maintained continuously at normal value.

KEROSENE AS A GAS ENGINE FUEL

By L. G. Heimpel, O.A.C.

THERE are hundreds of gasoline engines in use on Ontario farms at the present time, which are not the cheap source of power that they once were, and still should be, because of the recent rise in price of gasoline. A gasoline engine in good working order, and with gasoline at fifteen to twenty cents a gallon, is as satisfactory and as cheap a form of power as any other within the reach of the average farm.

Some years ago, gasoline was considered fairly good in quality when it tested 70-72 (Baume scale). At the present time it tests all the way from 59 to 66, which means that the speed with which it evaporates has decreased by the difference between these figures. In other words, volatility, which is the quality which makes it valuable as an internal combustion engine fuel, has deteriorated by that amount. The hydrometer (Baume scale), gives the test of average kerosene (coal oil), as from 42 to 46, which shows us that the difference between the volatility of coal oil and that of gasoline is growing less. In spite of the fact that the quality of gasoline is deteriorating we find the price rising—almost doubling that of a few years ago—and it behooves us to find some way of using a cheaper fuel for our gasoline engines.

Kerosene as a Substitute

For this purpose we have found kerosene, as well as naptha and fuel oil, to be quite satisfactory. Furthermore, it is an easy matter, as well as one that involves little expense, for any man who has taken the trouble to find out why and how his engine runs, to convert his engine, which was made to burn gasoline, into a kerosene burning engine.

The Relation of Kerosene and Gasoline

Before going on to describe the essentials of a coal oil burning device, we shall endeavor to show what gasoline and kerosene are, and how closely these products of the oil refinery are related. Both are products of petroleum. The crude petroleum is distilled in large iron stills and purified. The mass of oil is heated from 120 degs. C. to 150 degs. C. and held at, or near, the highest point mentioned, and all the vapor that passes off at that temperature is called gasoline. When no more vapor passes off, the temperature of the mass is raised from 150 degs. C. to 300 degs. C., and all vapor passing off at that temperature is condensed in a separate tank and forms such products as kerosene, naptha and fuel oils. Kerosene is therefore composed of the same constituents as gasoline, but it will not evaporate as readily as the latter, and it contains a larger percentage of carbon. Kerosene really contains more heat units per gallon than gasoline, but the problem before us is—how to get them out?

The conditions essential to the burning of kerosene are:—

1. Kerosene must be heated to its evaporating point outside of the cylinder and held at that point until it is ignited by the electric spark in the explosion chamber.

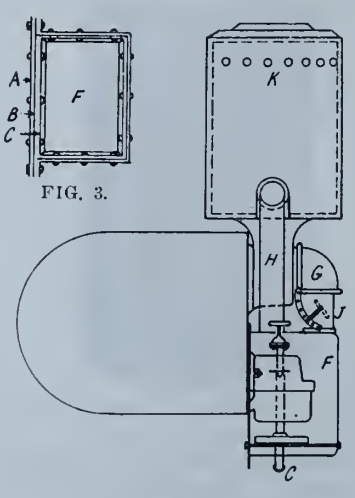


FIG. 3.

FIG. 1.

2. The air which is drawn in through the carbureter must be heated.

3. Water must be fed into the cylinder at the same time.

Heating the Oil

It is first of all necessary to state that up to the present we have discovered no satisfactory method of starting our engines on anything but gasoline, and hence appliances for this purpose must be provided. There are two kinds of fuel feeds in use at the present time—first, the gravity feed, in which the fuel tank is above the carbureter and the feed regulated by a float or diaphragm, and second, the constant level feed, in which we have the fuel level kept uniform by pumping a surplus of fuel into it; the excess running back to the tank through the overflow pipe.

The devices employed for heating the fuel in a gravity-feed engine are illustrated in Figs 1 and, 2 Fig. 1 representing an end view of a cylinder, carbureter and muffler of a gasoline engine, while Fig. 2 is a side view of the same. The dotted lines show the carbureter and heating tank D as they are enclosed in the box F.

On its way from the tank to the cylinder the oil passes through pipe A in the stand-pipe B, which is also a sediment and water trap, then through pipe C into heating tank D, from which it is drawn into the expansion chamber through the needle valve E. The heating tank should be either a thin rectangular tank holding from one-half to three-fourths of a pint of fuel, depending on the size of the engine, or it may consist of a coil of perhaps six or eight feet of ½ in. flexible copper tubing in which the oil is heated. In order to keep the fuel hot enough it is necessary to heat the carbureter as well as the oil; this is done by enclosing the carbureter in the sheet iron box F and piping about 40 or 50 per cent. of the exhaust of the engine into it, allowing it to escape through a hole in the opposite corner of the box. This is done by cutting a hole into the exhaust manifold and leading the exhaust through pipe G into the heating box. In Fig. 1, J shows a home-made butterfly valve by which the amount of heat entering the heating box can be diminished or increased at will. The construction of the heating box F is explained in Fig. 3, and with a little modification a similar device can be made to fit almost any engine. In Fig. 3, A is a stiff sheet iron plate which is held in place by being clamped in with the gasket on the studs which hold the carbureter. The top, bottom and one side of this box are one piece of metal bent to shape. The ends are of the same material and are fastened to the sides by bending the edges to form a flange, then bolting the sides and edges together with stove bolts. The joints can be made as tight as necessary by inserting a layer of asbestos paper.

Starting an Engine

The operation of starting an engine equipped in this manner is as follows:—

1. Close stop cock M so as to prevent kerosene from running into the carbureter.

2. Drain the kerosene out of the carbureter and heating tank through stop-cock N, after which close N.

3. Open stop-cock L to allow gasoline to run into carbureter and start the engine as usual. When it is hot, all that is necessary to change to kerosene is to close stop-cock L and opening M, so as to allow the kerosene free passage to the carbureter.

The principle for heating the fuel in an engine with a pump and constant level fuel feed remains the same, but

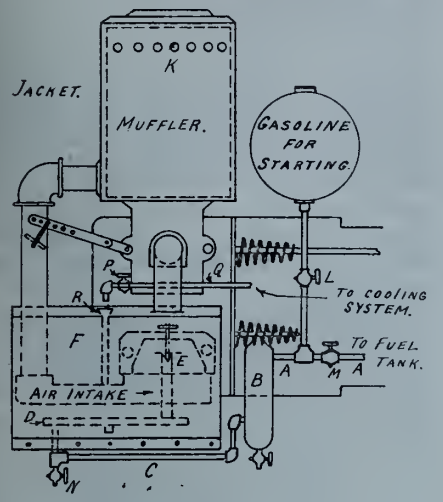


FIG. 2.

since a far larger amount of fuel is being pumped through the system than the engine requires, it follows that the tank heater is not efficient. Therefore, we must resort to such a device as is shown in Fig. 4. In this figure, O is the end of the cylinder of the engine; F is a coil of about 15 feet of quarter-inch pipe coiled around the exhaust pipe into which a series of holes have been drilled for the escape of hot gases; N is a sheet iron cover which encloses the coil of pipe.

The fuel is pumped through the pipe C, Fig. 4, into the carbureter at P, and the excess returns to the tank through overflow-pipe D. When kerosene is used the valve K is closed and the oil is forced through the coil F where it is

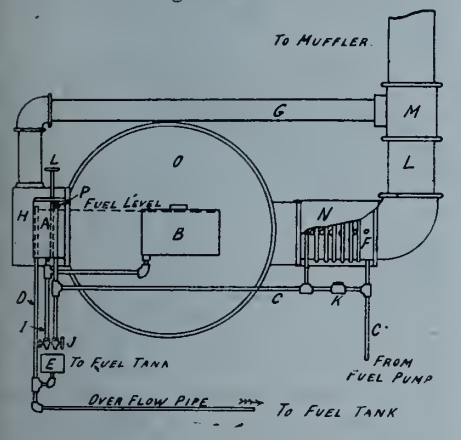


FIG. 4.

heated. When gasoline is used as fuel, opening of the valve K will allow the passage of the gasoline without heating it.

The heating of the carbureter is brought about in a manner similar to that in Figs. 1 and 2.

In starting an engine equipped as in Fig. 4, the following points are necessary:—

1. Drain kerosene out of carbureter through pet-cock on pipe I.

2. Fill tank B with gasoline. This tank should be large enough to hold for 20 minutes running. It is placed so that its top is level with the top of the carbureter and its bottom level with the bottom of the carbureter.

3. The pet-cock J is opened so as to allow the escape of all kerosene which is pumped through the pipe C, back to the tank.

4. Start the engine and when gasoline is run out turn on the kerosene by closing pet-cock J.

Heating the Air

It is necessary to heat the air so as to prevent condensation of the vaporized fuel particles into the liquid by the inrush of cold air into the air tanks. This is very important, and if the passage between the carbureter and the cylinder is a long one, and in a multicylinder engine it must be jacketed and heated with exhaust or the fuel mixture will condense on its way to the explosion chamber.

The best way to heat the air is to force the intake air to be drawn over the hot surface of the muffler or exhaust pipe. In Fig. 2 is shown a muffler with a jacket of sheet iron. The space between the jacket and the muffler should be no more than half an inch. All the air is drawn in through the holes K at the top of the muffler and is conducted through the pipe H to the carbureter.

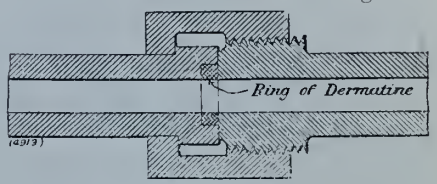
The Feeding of Water

Water is fed into the carbureter of a kerosene burning engine for two purposes, to prevent "knocking" and to prevent carbon deposits in the cylinder and consequent fouling of the ignition apparatus. Modern kerosene burning engines are fitted with a water carburter of similar design as the fuel carbureter, but when remodelling an engine not fitted for kerosene we find that a device such as is illustrated in Fig. 2 answers the purpose very well. Water taken from the cooling system of the engine passes through pipe Q and drops into the funnel R, thence into the air intake. The amount of water fed can be regulated by pet-cock P.

During the summer of 1916 we used a device as just described on the twenty horse-power engine driving the traction ditching machine used as a demonstrator by the Department of Physics of the Ontario Agricultural College. The writer made a number of actual working tests for the purpose of ascertaining the efficiency of kerosene and other cheap fuel oils as compared with that of gasoline. In each test we found that the gallon of kerosene did as much work as a gallon of gasoline. This means that with kerosene at from 12 to 13 cents a gallon and gasoline at from 33 to 35 cents, our fuel bill was cut to less than half of what it would have been had we been burning gasoline. Gasoline is high in price; the demand is growing; and the supply is limited; therefore we cannot see that it is likely to become any cheaper. For these reasons we hold that gas engine owners cannot do better than to equip their engines so as to burn kerosene.

HYDRAULIC JOINT PACKING

IN a recent issue of the *Philosophical Magazine* the Earl of Berkeley and Dr. Burton describe a simple form of joint packing, which is, they state, tight to start with and maintains this tightness



HYDRAULIC JOINT PACKING.

up to the highest pressures they have employed, and which have attained 1,500 atmospheres, or say, 10 tons per square inch. As will be noted from the accompanying sketch, the pipe ends are faced, and a recess is cut in one to take the ring of dermatine shown. Before assembly, this stands just a little over, and is thus slightly compressed when the joint is tightened up. Either red or black dermatine may be used, but the red, being harder, is more easily machined. The joint is said to be equally good for water or oil, and is as suitable for a flanged joint as for a screwed coupling. It is also said to be as satisfactory with large pipes as with small.

Cooling Electrical Machinery.—In the cooling of electrical machinery, with the high speed units of large output, the designer is seriously handicapped, says the *Electrician*. As turbo-alternators go in these days, the 15,000 kilovolt-ampere alternator is a machine of medium size. In such a machine the total loss is about 545 kilowatts, and an enormous volume of cooling air is required for carrying away the heat due to this loss. According to B. G. Lamme, a simple approximate rule for determining the quantity of cooling air required is that an expenditure of one kilowatt in one minute will raise the temperature of 100 cubic feet of air 18 deg. cent. Therefore, for a temperature rise of the outgoing air of 20 deg. Cent. above that of the incoming air, a loss of 545 kilowatts will necessitate a supply of ventilating air of approximately 50,000 cubic feet per minute.

Irrelevant Remark Defined.—She was a pretty girl, quite the belle of the class, and the cause of many a heart flutter. The teacher asked her one day if she could define an irrevelant remark.

"I can't just define it," she answered, "but I can give you an example."

"Well give us an example, please."

"Well, if I was going through a dark hall and met Billy Peterkins and he should ask me the time and I should say, "my your nose is cold," that would be an irrelevant remark.

Boiler-House Operation in South African Power Plants--I.

By T. G. Otley and Verney Pickles

In the January issue of the Journal of the South African Institution of Engineers, the subject of Boiler House Operation and Maintenance is discussed, with special reference to the Rand Power Co. plants. In what follows, both power plant superintendents and operators will find much to interest them, and no less so when cognizance is taken of the meantime steam coal situation not only in Canada, but in manufacturing countries the world over.

FOUR distinct power stations—Brakpan, Simmerpan, Rosherville and Vereeniging, are described by the authors, particular attention being given, however, to the boiler plant section of each, and in special manner to the coal and ash-handling equipment. Babcock & Wilcox water-tube boilers of a combined total of 102 units are installed.

Coal

The problem of burning coal efficiently is one largely dependent on the coal itself. It is a much simpler proposition with some coals than others, and although the results of experience given are chiefly concerned with Transvaal coal, the general principles outlined are generally applicable for burning coal on chain grate stokers. The great bulk of the coal burnt under our boilers is duff of a very small size, and a mixed coal of duff, peas, and small nuts. The most important factor of affecting efficiency is the different character, energy value, and size of the coal burnt. Few coals, even from adjacent pits, have the same character, even though the energy value may be approximately the same, and efficient results cannot be obtained unless the peculiarities of each coal be carefully considered.

Although there is a standard laid down by the Standards Committee for nuts, peas, and duff, yet each colliery manager appears to have his own ideas on the subject, and there is fortunately a tendency in many cases to increase the size of the screens above the ¼-in., defined as a duff screen mesh, but even though this may be increased to ⅜-in. or ½-in., the tendency is for duff coal—especially that from the Witbank district—to contain more and more absolute dust.

Table I. gives the results of screening tests on certain duff coals supplied to us under contract. The serious factor is that of the coal which passes through a ⅛-in. square mesh, a very large proportion is absolute dust, which either clogs up the fire or falls through between the links of the grate. At one time an attempt was made to burn one of the Witbank district duffs alone and dry as received, with the result that 70 per cent. by weight of the coal riddled through the grate into the ashpit unconsumed.

In order to burn duff coals efficiently, it is essential that they should be mixed with other coals, but the mixing has to be most carefully done. As far as possible separate outside bunkers are set apart for different coals, and, when different classes are to be mixed, care is taken that this is intimately done in the conveyor from the outside to the overhead bunker. The most serious consequence of the Brakpan bunkering arrangement is that coals cannot be mixed, and each coal—whatever its size and energy value—has to be burnt alone. It is general knowledge that duff coals burn better when wetted. A considerable difference of opinion exists as to the reason, but that it is possible to obtain higher furnace temperatures and a higher CO_2 is certain. Although there may be some chemical explanation, there is no doubt that some portion of the improvement is due to the moisture expanding and moving the particles of dust coal apart, thus allowing more even access of air through the fuel bed. Unless duff coal is wet it goes over the grate like a blanket and at a low furnace temperature, and if the draught is increased too high it breaks up the fuel bed into ridges, through which large volumes of excess and cold air enter the furnace, lowering its efficiency. Tests have shown that when burning dry duff alone, the CO_2 is only in the region of 6 per cent., whereas this can be brought up to 10.5 to 12 per cent. when evenly wetted.

Even though these results can be obtained when burning duff alone, it pays whenever possible to mix the duff with a larger mixed coal. We have found by experience that it pays to wet all our coals, whether mixed or duff, except only clean peas or nuts, of which, however, we obtain and burn a relatively small tonnage. In order to ensure success, the coal has to be wetted uniformly, and this is not such a simple matter as it might appear. If special provision were made in the original design of a station, it might be a much simpler matter, but, where the lay-out does not fit in, it is not easy to wet the coal evenly without making it too wet. Good results are obtained by spraying the coal as it falls from the filler into the conveyor buckets.

TABLE I.—SCREENING TEST ON DUFF COALS.

	A	B	C	D
	%	%	%	%
Through ⅛ in. square mesh	50.00	48.40	59.80	60.00
Over ⅛ in. and through ¼ in.	32.60	44.30	35.00	33.20
Over ¼ in. and through ⅜ in.	10.10	5.60	2.60	3.40
Over ⅜ in. and through ½ in.	5.00	.80	.40	1.60
Over ½ in. and through ⅝ in.	2.30	.90	2.20	1.20
	100.00	100.00	100.00	100.00

Sample A is designated a mixed coal of duff, peas, and nuts; the remaining samples are supplied as duff.

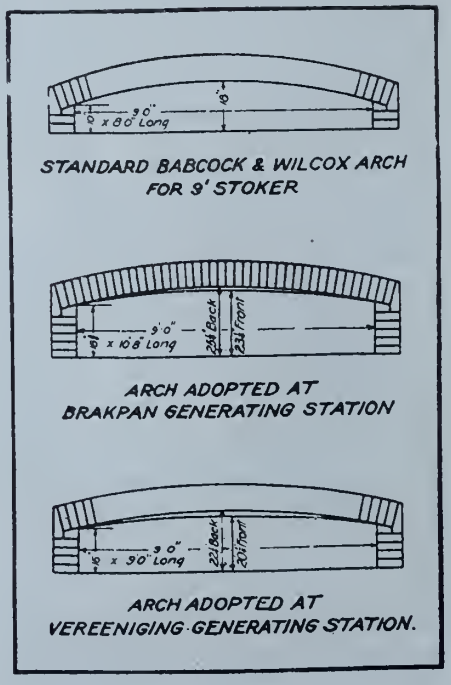


FIG. 1.

Objections to Wet Mixture

The most serious objections to this are that it vitiates the readings of the weighing machines to the extent of the added water, and a quantity of coal sticks to the buckets and is weighed over and over again. There is the further reason that if the coal is too wet it sticks in the overhead bunkers and in the chutes, and considerable labor is involved in getting it down to the stoker hoppers. The most successful scheme so far adopted has been to spray the coal as it leaves the overhead bunkers and enters the coal chute leading to the stoker hopper, but this can only be done when the feed is constant, that is, when the furnace conditions with regard to the thickness of fires and grate speed are not changed for long periods. If an alteration has to be made, then the coal is either too wet or too dry, and the results are unsatisfactory. The special difficulties of burning the low-value coals are further

dealt with when considering the boiler-house problems at Brakpan and Vereeniging.

Brakpan Power Station Boiler-house Conditions

The principal objection to the Brakpan bunkering arrangement previously referred to is that it does not permit of the mixing of the various coals burnt. In the old boiler-house, with a Witbank district mixed coal of duff, peas, and nuts is burnt, with average consumption about 1,300 tons per week. In the new boiler-house the coals burnt are obtained from the local collieries. These are of relatively low values—in one case of unusually low value, averaging something less than 2.20 kilowatts per pound (7,500 Btu. per pound), and containing between 32 per cent. and 36 per cent. of ash. If it were possible to evenly mix these coals with those of higher value, considerably better boiler-house efficiencies would be obtained. These low value mixed duff and pea coals have, unfortunately, to be burnt alone, and, as a result, the boiler-house efficiency is lower to-day than it was before the station was extended. The units sent out and the boiler-house efficiencies are given in Table II., and clearly show the drop that has taken place in 1915-1916 as a result of burning large tonnages of low value coal.

TABLE II.—BRAKPAN BOILER-HOUSE EFFICIENCIES.

	1914	1915	1916 (4 months)
Units sent out	36,324,000	116,725,000	42,185,000
*Boiler-house efficiency	76.2%	72.7%	71.2%

*Including pressure and temperature losses up to the turbine stop valve.

Although the efficiency is lower, we have gained considerably in economy. After all, the end we are striving for is not necessarily efficiency, but economy, i.e., the production of power at the lowest possible cost. We have no doubt whatever that, if a well-graded pea coal of an energy value of 3.45 kilowatts per pound were to be burnt at Brakpan, the boiler-house efficiency could be maintained, month in, month out, at 80 per cent., but this would be bought at too high a cost, i.e., at the expense of economy. It should be mentioned that the efficiencies given in Table II. are the average efficiencies over the years mentioned, and include all losses—pressure and temperature—up to the turbine stop valve, i.e., they represent the proportion of the heat energy of the coal available as steam energy at the turbine stop valve. With reference to the low value coal above referred to—2.25 kilowatts per pound—the proximate analysis of a good sample is given below:—

	Per Cent.
Moisture	5.6
Volatile matter	18.7
Fixed carbon	43.2
Ash	32.5
	100.0

This coal is so near the limit of what can be burnt commercially on chain grate stokers that a very slight variation downwards in value causes serious loss in boiler capacity and efficiency, and it is no infrequent occurrence to have to re-light the fires with higher value coal and reheat the arch before they can be got going again. It was only after an exhaustive investigation that the conditions necessary for burning those low value coals were reached. The principal factors are: Arch design; grading; draught; a thorough saturation of the duff or slack coal with water.

Dealing with the arch design first, we had the benefit of our experience at Vereeniging, where we had considerable difficulties in the early stages of the station in burning Vereeniging coal on chain grates. The arches now standardized for the conditions at Brakpan are shown in Fig. 1. These arches, although 9 ft. span, have only a rise of 4½ in. at front and 6½ in. at the back. It will be noted that they are 10 ft. 8 in. long, as against the standard arch of 8 ft. long. We find that they stand quite well when burning low value coal—furnace temperature of 1,200 to 1,300 deg. Cent.—but that with Witbank district coals and furnace temperature of 1,300 to 1,400 deg. they have a relatively short life, the last 3 ft. of the arch collapsing. The conditions giving the best results with the low value coals are:—

	Peas (½ in. to ⅞ in.)	Slack (0 in. to ¼ in.)
Fire thickness	6 in.	4¾ in. to 5' in.
Grate speed	No. 3	No. 4
Draught at uptake	1.2 in. to 1.3 in.	1.7 in. to 1.8 in.
Draught over fire	.50 in.	.50 in.
Coal burnt per square foot per hour	32 lb.	35.0 lb.

These conditions have to be maintained as steadily as possible. It is found practically impossible to do any regulating with these fires, and all variations of load have to be met by those boilers burning the higher value coal. The coal is now graded into two sizes, 0 in. to ½in. and ½ in. to ⅞ in., and as a result we are obtaining better efficiencies and higher evaporations per boiler. At the present time, the boiler-house efficiency is in the region of 72.5 per cent., and will probably come up to 74.5 per cent. We find it necessary to saturate the slack mixture (0 in. to ½ in.), but the peas (½ in. to ⅞ in.) can be burnt dry.

The colliery management find it difficult to maintain the energy value of the coal supplied at 2.25 kilowatts hours-pounds (7,700 B.t.u.), and it occasionally falls to as low as 1.82 kilowatts hours-pounds (6,250 B.t.u.). The principle trouble is to distinguish between the shale rock, and coal, as it passes over the picking belt, and it occasionally happens that the coal is thrown away and the rock and shale delivered to us. We are informed that where efforts have been made to burn low value slack coals in England it was found essential to thoroughly saturate the coal with water.

Grading the Fuel

The Vereeniging station was started up in September, 1912, and we were very soon in difficulties owing to the character of the coal. A further difficulty was that, as our whole requirements were obtained from one pit, the small by-product was insufficient for our requirements. A coal crusher was therefore installed. The combination of relatively low value—2.82 to 2.92 kilowatt-pounds (9,600 to 10,000 Btu. per pound)—and the large size and wide grading proved a very difficult problem, and one that engaged our attention for a considerable time. Although 17 or 18 boilers out of 20 installed were steamed, we could not obtain the normal full load electrical output for the station. The problem was first attacked by attempting to crush the coal to a smaller size. This improved matters. The coal from the crushers was then graded into two sizes, nuts (between 1½ in. to ⅞ in.) and slack (between 0 in. to ⅞ in.). In addition, we obtained a quantity of peas. Corneiia coal has the following average proximate analysis;—

	Per Cent.
Moisture	7.0
Volatile	22.0
Fixed carbon	52.5
Ash	18.5
	100.0

The grading of the coal certainly improved matters, but the solution of our difficulties was in the design of the stoker arch. It was found that with the standard type of arch the coal could not be got to ignite readily, with the result that the grates had to be run on Nos. 1 and 2 speeds. Under these conditions it was found impossible to obtain the normal evaporation from the boiler, and it was obvious, therefore, that as the coal was slow burning and difficult to ignite, that very much thicker fires would have to be run. With thick fires the fuel bed was much too close to the arch, with the result that the velocity of the gases was so great that they had not time to raise the brickwork to the high temperature which is necessary for continuous ignition. Experiments were made, and we ultimately adopted the type of arch shown in Fig. 1. The conditions which give us the best results with the large crushed coal are: 8 in. fires; No. 2 speed; 1.30 draught at the chimney uptake; and with the crushed slack:—4½ in. to 4¾ in. fires; Nos. 3 and 4 speed; 1.6 to 1.7 draught at the chimney uptake.

It is found that the high arch gives equally satisfactory results with the slack as with the large crushed, and we believe that even better results would be obtained were it possible to raise the arch higher still. We are, however, limited by the position of the mud-drum relative to the grate level. With the large crushed coal, when clean, we can steam

the boilers continuously at 25 per cent. overload, and still obtain a continuous efficiency of between 78 and 80 per cent. The efficiency when burning slack varies between about 66 per cent. and 75 per cent., depending upon the amount of dust in the coal. A peculiar characteristic of Cornelia coal is that, if it is left too long in stock on the outside coal staithes, it disintegrates badly. The effect of the duff on the burning efficiency of the crushed coal is also very marked, and we therefore endeavor to run with a minimum stock. The yearly outputs, station load factor, and boiler-house efficiencies, are shown in Table III.

A determined effort is being made to improve the average boiler-house efficiency, and there is no doubt that this will be effected if we can obtain a well-graded small nut coal, but having to take crushed run-of-mine coal, including slack and duff(which from time to time contains a large percentage of dust), renders this a very difficult problem, as the smaller nut made by the crusher the larger the percentage of duff and dust made.

TABLE III.—VEREENIGING POWER STATION OUTPUT, LOAD FACTOR, AND BOILER-HOUSE EFFICIENCY.

	1913	1914	1915	1916 (4 months)
U. S. O.	172,840,000	229,600,000	269,400,000	86,050,000
Load factor	56%	59%	67.4%	66.5%
*Boiler-house efficiency	69.8%	70%	72.1%	74.80%

*Including pressure and temperature losses up to the turbine stop valve.

Boiler-house Losses

We do not apply a CO_2 recorder to each boiler. In general there is one instrument to either two or four boilers, The CO_2 recorder is a good servant, but a bad master. A fireman, if left to himself, can readily obtain a good CO_2 chart, although the efficiency of the unit may be low and the boiler not doing its share of the load. This he can do by running a heavy fire at the back, thus allowing unburnt fuel to go over with the ashes, and by running on a reduced draught, thus reducing evaporation. These points, however, are very carefully watched, and as we aim at a CO_2 of 12½ per cent. there is little occasion for a fireman to specially nurse the particular boiler to which the recorder is connected. The gas sample is taken at the uptake between the economizer and the chimney, except in the case of those boilers with Green economizers, in which case the gas is taken from the uptake between the boiler and the economizer. The reason for this is that there is an unavoidable air leak with the latter type of economizer, which should not be debited against operation.

The average percentage of CO_2 is approximately the same at all stations, and is in the order of 10.5 per cent. when the boilers are steaming. The recorders are disconnected when the boilers are banked, as during this period the CO_2 would naturally be very high. The chimney uptake temperatures, however, vary according to the proportions of the boiler in relation to the grate area and the quantity of coal burnt. With the same CO_2, the boiler efficiency will naturally vary with the uptake temperature.

It has frequently been stated that it is possible to obtain the same efficiency with low as with high value coal. In commercial working this is impossible, even with the same CO_2 and uptake temperatures. For instance, when burning either Cornelia coal at Vereeniging, or Schapenrust coals at Brakpan, the chimney losses are never less than 14.5 per cent., whereas when burning Witbank district coals under exactly the same conditions of CO_2 and chimney temperature, the chimney losses are about 12.7 per cent. Furthermore, it is practically impossible to obtain the same furnace efficiency, as the unburnt carbon in the ash is considerably higher with low value coals containing a high ash percentage, and there is a further loss with those low value coals which require saturating with water, due to the evaporation of the added moisture.

The ashes are not regularly analyzed for unburnt carbon, but on frequent tests it has been found to be between 4 and 6 per cent. of the energy value of the coal. The larger the grade and the higher the ash percentage, the greater the loss due to unburnt carbon. It is usually considered that radiation losses from boiler and economizer casings are in the order of 2 to 3 per cent., but we believe them to be considerably higher than this, and more like 5 to 6 per cent. for our type of isolated boiler unit.

We estimate that the distribution of the coal energy at our power stations is as shown in Table IV. It will be seen that the chimney loss constitutes the largest of the three items making up the total loss. The greater part of this is inevitable, and is inherent in the design and proportion of the boiler and economizer. It is obvious that the gases cannot be cooled down to the temperature of the inlet feed water, unless the economizer heating surface is made infinitely large, but it would appear that money spent on larger economizers would have been a good investment. In commercial boiler practice the products of combustion are never discharged to the atmosphere at less than 100 deg. Cent., and consequently the steam goes away with the chimney gases to the atmosphere. In all our calculations we have taken the highest calorific value of the coal. It is difficult to defend this practice, as it is undoubtedly sounder and more logical to take the lower calorific value.

In comparing boiler efficiencies one should be careful to note whether the higher or lower value is taken, as it materially affects results. The loss with the ashes can to a certain extent be controlled, but it depends upon the character and size of the coal burnt, and is probably higher with us than in other power stations, owing to the fact that we burn coals containing a higher percentage of ash, and at Vereeniging too wide a grade to be burnt at the highest efficiency on chain grate stokers. The radiation loss is outside control, and is dependent upon the design of the plant. Boilers set in single units, exposed on all sides, must necessarily have a higher radiation loss than boilers in rows with brickwork settings. In order to arrive at losses due to banking, a series of tests were carried out at Rosherville, covering the whole cycle of operation. The tests lasted several days, the boiler being steamed off for a number of hours, then banked, and got away again in the ordinary way. It was found that about 1,800 lbs. of coal was consumed during the banked period, and including the coal used in bringing the boiler up to pressure and temperature. This was at the rate of about 175 lbs. per hour, or, say, 3 per cent. of normal load consumption. It is obvious that this is considerably less than the radiation loss when the boiler is steaming at normal load, as during the time that the boiler is on the bank the average gas temperature is very much less than when working.

Bonus Schemes

The matter of paying firemen and others a bonus to obtain higher efficiency has been given careful consideration, but no scheme has so far been evolved which would be fair to the men and to the company. Payment on CO_2 results is out of the question, as a high percentage can be obtained, and yet the boiler unity efficiency be low. Furthermore, it is more difficult to obtain a high CO_2 with some coals than with others. The usual bonus scheme is based on pounds of coal or B.t.u. per unit generated. Neither of these will be satisfactory under our conditions of working owing to the widely different values and characters of the coals burnt at the stations, and also owing to the circulating water inlet temperatures affecting the steam consumption of the turbines, both of which are outside the control of the operating staff. The coal consumption is largely affected by the load factor and the utility factor of the plant, and its condition of cleanliness, which is a matter for the maintenance department, and also outside the control of the operating employes. Taking all these factors into account, it is difficult to see how any equitable basis of payment can be arrived at, and we therefore rely upon intelligent supervision to obtain the results.

TABLE IV.—WEIGHTED AVERAGE BOILER-HOUSE EFFICIENCY AND LOSSES.

	Brakpan %	Rosherville %	Simmerpan %	Vereeniging %
Energy to water	71.2	74.6	76.1	74.8
Chimney losses	15.5	13.2	12.7	14.7
Loss in ashes	6.5	4.5	4.5	5.5
Radiation and banking	6.8	7.7	6.7	5.0
	100.0	100.0	100.0	100.0

REFRIGERATION DEPARTMENT

EXTRAVAGANT REFRIGERATING PLANTS*

By Victor J, Azbe.

ABOUT the most wasteful power plants are those of ice-making and refrigerating; many make three or less tons of ice per ton of coal, a few about six tons, and only the very exceptional plants reach the ten-ton mark. All except the very small ones and those near coal mines should be making ten tons of ice per ton of coal burned, and none less than six tons. One reason for the existing bad conditions is the low load factor. While during warm weather the equipment is forced far beyond its economical rating, in winter it stands idle. This low yearly load factor, which, in most plants, is between 20 and 40 per cent., is to a certain extent responsible for many plants not being more successful and profitable. There are ice plants, for example, the Polar Wave of St. Louis, that operate with a load factor of over 100 per cent. the year round. This is made possible by providing proper size ice-storage houses, which reduces the necessary size of power plants, machinery, ice tanks, etc., and consequently also the fixed and operating charges. Besides the variable load conditions, the following are factors responsible for uneconomic conditions:

Uneconomical Factors

Inefficiency in the boiler houses, where often the coal is burned with from two to four times the air actually required.

The fact that distilled water ice is made and uneconomical prime movers and auxiliary machinery are operated so that sufficient exhaust steam for distilled water will be obtained. This type of plant also condenses the exhaust steam in atmospheric condensers, with the result that the engines operate against a back pressure instead of under a vacuum.

Due to a lack of thorough understanding on the part of many operators of the physical laws governing the compression of gases, refrigeration is often obtained with from 20 to 40 per cent. more power than actually required. Many operators insist that ammonia compressors operate best with low back pressures, while exactly the opposite is true.

To be able to operate with high back pressures, ice tanks, brine tanks and coolers should be designed and piped so that proper temperatures will be maintained without too great a temperature difference between the air (or brine) and the evaporating ammonia. Where two (one high and one low) temperatures must be maintained, the power required per ton of refrigeration will be greatly reduced by installing high and low-pressure suction lines connecting with a multiple-effect compressor attachment, thus enabling the compressor to operate with very nearly the efficiency obtained with the higher back pressure.

A compressor operating against a condenser pressure of 185 lb. and with 12 lb. suction pressure, will require 3.07 b.h.p. per ton on ice-making, while the same compressor operating with 35 lb. suction pressure will require only 1.9 b.h.p., or a gain of 38 per cent. An economical ice plant will cool the liquid ammonia, leaving the condenser down to the temperature of the coolest water by passing the water on the way to the condenser through a liquid-ammonia cooler. The heat extracted here will be a clear gain. From the water cooler the ammonia will pass to a second cooler where the liquid ammonia will be further cooled by the evaporation of ammonia on the outside of the liquid coil at a high evaporating pressure, preferably 35 lb., or by gas returning from the expansion coils in heat exchangers. The distilled water, in the meantime, will be cooled to 40 deg. in the fore-cooler by liquid ammonia evaporating at 35 lb. pressure. Thus about 40 per cent. of the work will be done at 35 lb. and 60 per cent. at 12 lb. The ammonia gas from the liquid ammonia, water fore-coolers and ice tanks will then be led into two separate suction lines to either two different compressors, or to a compressor with the two ends separated and one compressing gas at 35 lb. and the other at 12 lb. suction pressure. By this arrangement about 15 per cent. less power will be consumed. and the capacity of the compressor and ice tanks will be greatly increased.

Raw-water-ice systems have been so perfected that ice can be made from raw water that is wholly equal to distilled water ice. Where the water is very bad, it can be purified or a multiple-effect distilled water system used, avoiding any occasion to employ uneconomical steam machinery to get the required quantity of ice water.

Compression System Improvement

The compression system of ice-making with simple non-condensing Corliss engines and its production of six tons of ice for every ton of 12.000 B.t.u. coal burned under its best conditions, high load factor and excellent operation, could be improved upon by various other combinations, as follows:

	Tons of ice per ton of coal
Compression, simple Corliss, non-condensing	6
Compression, compound Corliss, non-condensing	7
Compression, simple Corliss, exhausting into generator of absorption machine	8.5
Compression, compound Corliss, condensing	9.5
Compression, compound Corliss, exhausting into generator of absorption machine	11.

These estimates are for well-operated ice plants, and the production could be further increased by adding special devices and by special arrangements, economizers, multiple-effect compressor attachments, flooded and jet ammonia condensers, vertical small clearance compressors, heat exchangers, flooded systems, etc., also by using Uniflow engines supplied with highly superheated steam. In some refrigerating plants Diesel and semi-Diesel engines are used to drive ammonia compressors with great success, while in others they are not profitable, but this is chiefly the fault of improper design, management and operation and not of the oil engine.

By operating ammonia compressors properly, that is, with a high discharge temperature and leading the gas through a feed-water preheater, considerable heat could be saved, and thus allow, if economizers are not used, employing more efficient auxiliaries or discharging their steam into the generator of the absorption machine.

Condenser Efficiency

Condenser efficiency is also very important in ice and refrigerating plant operation, and it is regrettable with what persistence the low efficiency straight-pipe condensers are used, while there are excellent types of flooded, jet and other condensers on the market. Some of these condensers are from two to three times as efficient as those in general use, because they transfer heat from liquid to liquid instead of from liquid to gas. An entirely new type of condenser, employing high velocity and counter-current effect, gives a very high efficiency and remarkable results.

Many large plants are operated non-condensing, and while the exhaust steam, in winter, is used for heating, in summer, a large part of it is ordinarily wasted. It would pay some one to buy this steam and use it in an absorption ice machine. Another good combination would be an exhaust-steam absorption ice plant and an electric-light plant, with

*From a paper read before the American Society of Mechanical Engineers, New York City.

the resulting high efficiency of the two combined.

Opportunities for economy in ice plants are great, not only by better equipment and arrangement, but also by better operation, for many plants are ridiculously inefficient. While operating engineers are coming to realize the importance of frequently indicating the steam engine, they are slow in becoming impressed with the importance of indicating the ammonia compressor. Although simply inspecting the ammonia-compressor indicator card will not reveal much, by drawing the adiabatic and isothermal curve, and by drawing the suction and discharge pressures existing in the pipes leading to and from the compressor and noting their relation to the suction and discharge pressures in the cylinder, a good idea of conditions will be gained. Thermometers in the suction and discharge pipes at the compressor and proper interpretation of the readings obtained are also of great value in the efficient operation of an ammonia compressor.

The author knows of ice plants where compressors operate with only about 70 per cent. of their volumetric efficiency and, in addition, the wire-drawing of ammonia gas through improperly designed suction piping and suction valves causes an increase of 10 to 15 per cent. in the power required per ton of refrigeration, because the ammonia in the cylinder before compression is more rarefied than in the evaporating coils. These conditions would not have been discovered without the indicator.

REFRIGERATOR INSULATION*

By Robert F. Massa.

IN the following notes on refrigerator insulation, it is the writer's intention to call attention to several elementary physical facts—facts which everyone knows and the regard for which would seem to be engineering common-sense, and yet facts which are very apt to be neglected in insulating cold storage compartments. Some repair work recently done on refrigerators in a large New York hotel offers an excellent example of how not to insulate a cold room. The fact that this was a stationary installation does not affect its importance as an example of wrong method. These refrigerators, when originally built, were constructed by cementing cork sheets against concrete floor, walls and ceilings, with wooden strips set in the cork. The cork was applied in two layers, 2 inches thick each, the second layer being secured to the first by cement and the strips of wood being set in the last layer applied. To these wooden strips there was secured an inner lining for the refrigerator made of white porcelain-enamelled sheets of steel.

Case of Water-Soaked Insulation

Upon examining this refrigerator after several years' service, it was found that the insulation, particularly in the lower part of the box, was water-soaked, that the steel had been almost completely rusted out, that the wooden strips holding the metal in place had rotted away, and that the moisture had worked down through the floor and was getting into the wine room located directly below the refrigerator. The defect in this design lies in the fact that it is not possible to fit these enamelled sheets close enough to the cork to do away with air pockets, and, if these pockets exist, the variations of temperature to which they are inevitably subjected mean alteration of pressure within them, and, consequently, interchange of air with the outside, the deposit of moisture and its gradual accumulation.

Moisture Deposit Increase

The deposit of moisture is increased where the cooling surfaces are placed close to the walls of the refrigerator, this action being due to the greater deposit of moisture at the lower temperature, and further, to the greater variations in temperature to which air pockets near the cooling surfaces are subjected. This same difficulty of making a perfectly tight wall holds, not only with the white porcelain-enamelled sheets, but with all metal sheets and with glass refrigerator lining. These glass linings are one of the most attractive appearing linings for refrigerators, but for the above-mentioned reason are not desirable as ordinarily installed.

The method used for correcting this set of refrigerators consisted in removing all ofthe defective insulation, replacing it with pure cork sheets set in Portland cement, using two layers of 2-inch sheets as before, and then finishing the inside of the refrigerators with cement with rounded or cove corners. In this way all air spaces are absolutely eliminated and a practically permanent structure is secured. There is, of course, a tendency which cannot be avoided for the cement to crack as it dries. This is taken care of by scoring the surface in rectangles so that the cracking occurs on these lines, and after the cement has thoroughly dried these cracks are filled with a paint, *i.e.*, a white enamel paint that is used for a final finish on the surface. A refrigerator finished in this way is not as attractive in appearance as the glass, or, for that matter, even the porcelain enamel on metal, but it is certainly a more sanitary structure. Another way to overcome the cracking difficulty in the cement is to give the cork a skim coat of cement, bed into this either a sheet of expanded metal or wire mesh of some kind, and then apply a final coat of cement. The two layers of cement are used to avoid any possibility of air spaces being left if the metal is secured direct to the cork, and then only a final coat of cement applied.

A further difficulty in the original design of the refrigerators under discussion was brought very forcibly to the attention of the men who did the actual repair work on this job. The work, unfortunately, had to be done while the kitchens were in service, and, although the weather was not specially warm, the men found the interior of the refrigerators so hot that it was impossible to work any length of time without going outside to cool off. Ranges and steam kettles were so close to the refrigerators that there was only space sufficient for the men working on the ranges or kettles to get about them and for a rather narow passage behind them, *i.e.*, between them and the refrigerators. When one stops for a moment to consider the purpose of insulation, namely, to prevent the flow of heat into the refrigerator, it would seem reasonable to so arrange the building as to reduce as far as possible the temperature to which the outside of the refrigerator is subjected.

The insulating material—namely, pure sheet cork—is cemented with a special cement directly to the steel surfaces forming the compartment. The second course of cork is set in asphalt after the first course has been carefully pointed up with an asphaltic cement mixed with fine regranulated cork. In this way all possibility of air spaces is eliminated and the chance of any moisture accumulating is avoided. The inside surface may, in this case as in the insulation described before, be finished in cement, although in some classes of work the cement can be omitted and an asphalt finish used instead. One cannot conclude from the suggestion that cork can be cemented directly on to the steel in the construction of refrigerator compartments on board ship that a similar construction is suitable for ice-tank work in stationary plants. In this work the surfaces of the tanks are, in general, not particularly true. There is also the difficulty of rivet heads which must have the cork fitted about them. In work of this size this fitting is apt to be done carelessly, with the result that air spaces will occur and the cork be forced out of place by freezing and melting of moisture.

Difficulty has been encountered, in one or two installations which the writer has seen, with the use of cork that had not been sufficiently pressed previous to baking. This cork was not as dense as it should have been and had not the mechanical strength it should have had. More or less air spaces were left in the cork, into which there was, of course, the tendency for moisture to penetrate, and, where the temperature was very low, this moisture froze and pried the sheets apart, completely disintegrating the insulation and requiring that the entire work be done over again.

*From a paper read at the 24th general meeting of the Society of Naval Architects and Marine Engineers, New York City.

London, No. 3, C.A.S.E.—On March 9, the stationary engineers of London, Ont., held an open meeting in the C.A.S.E. Hall, Messrs. McGhie, Moseley and Corrigan of the Province of Ontario Stationary Engineers Examining Board were present and took part in the discussion. Of local men, Messrs. Mellon, Campbell, Moll, Lyons, and Fowler, were the more prominent spokesmen. Visiting engineers and the "Examining Board" were afterwards tendered a banquet at the City Hotel .

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Vol. X. APRIL, 1917 No. 4

PRINCIPAL CONTENTS

Power Plant of the Hudson's Bay Co. Store, Vancouver, B.C... 73-76
General ... 76
Combustion in Hand-Fired Furnaces.
Power Transmission Section ... 77-80
Savings Made Possible by Ball-bearing Hangers....Friction and Lubrication of Shafting.
General ... 80
Value of Instruments in Power Plants .... Proper Feed Water....Explosions in Boiler Furnaces.
Observations on Safety Valves for Marine Boilers ... 81-84
General ... 84
Heating by Steam at Different Pressures....Advantages of Economizers .... Utilizing Exhaust Steam .... Reducible Losses in Power Plants.
Electricity and Hydraulics ... 85-86
Open Circuits in D.C. Armatures....Cycle Counter or Timing Device....Gigantic Voltage Regulator.
General ... 86-87
Kerosene as a Gas Engine Fuel....Hydraulic Joint Packing.
Boiler House Operation in South African Power Plants—I..... 88-90
Refrigeration ... 91-92
Extravagant Refrigerating Plants....Refrigerator Insulation.
Editorial ... 93
Post-War Problems of Labor.
The Operators' Point of View ... 94
Overcoming Trouble with Steam Pipe....Protecting Blow-off Pipes....Trouble with Shaft Breaking....Shaft Troubles ....Protecting Belt Laces from Vermin....Renewing Gaskets in Large Flanges .... Curing Auxiliary Valve Stem Trouble .... Simple Steam Trap .... Tank Skimming and Emptying Device....Repairing Valves in a Sewage Pump ....Converting Square Inches into Square Feet....Corrosion and Foaming .... Pounding in Pipes of Water Works System.
Steam Power Plant Auxiliaries ... 98-99
Oil Separators—I.
General ... 99
Boiler Failures and Losses Due to Scale....Kerosene a Remedy for Scale Troubles.
Progress in New Equipment ... 100-102
Combined Steam Turbine and Centrifugal Boiler Feed Pump ....Cell Mounting Oil Circuit Breaker.
General ... 102
Boiler Troubles Caused by Corrosion....Products of Combustion of Coal.
Projects and Developments (Advtg. Section) ... 48-51
Trade Gossip....Catalogues....Book Reviews.

POST-WAR PROBLEMS OF LABOR

THE introduction of shell manufacture into Canada, created a new phase of enterprise which, up until three years ago, had practically been an unknown factor in this country's industrial activities. The rapid expansion of munitions making, coupled with the drain upon the man power of the land, had the effect of causing a temporary dearth of skilled mechanics in many lines of manufacture. This feature of an unprecedented situation threatened the success of an obligation suddenly undertaken by Canada's captains of industry. During the early period of the war, when the call for volunteers was meeting with a wonderful response, our factories were being depleted of the trained men upon whom much reliance had been placed for the achievement of the new task; that of producing munitions for the Imperial Government.

Our metal-working firms had never before been called upon to produce on such an extensive scale, besides, little time was permitted to form a plan of action to meet the need. Equipment was apparently the essential factor, and a feverish start was made to obtain the machines most suitable for the purpose. Guided by previous practice in other lines of engineering output, the tools ordered for the new venture were naturally of standard pattern, with few or any of the auxiliary parts eliminated. The urgency and magnitude of the demand for these tools, and the inability of the machine tool builders to deliver equipment, created an unprecedented situation, the result of which has been the means of revolutionizing, not only the shell making industry, but is likely to establish a new standard in future engineering practice.

Probably never before in Canada's history have the resources of plant and individual been more rapidly developed than during the past three years. Instead of the delay in the delivery of equipment proving a drawback, it has probably been a blessing in disguise. Had sufficient standard tools been readily available at the commencement of the shell game, there is a large possibility that the increased production would not have been as rapid as the changed conditions have proved it to be. Unable to secure standard tools, shell makers began to equip existing machinery with special attachments or devices for the accomplishment of certain operations. Scrap heaps were explored and machines that had been "dead" for years were pressed into service, with such remarkable success that a foundation was started upon which a new and highly efficient line of special single purpose machinery was designed and constructed.

Owing to the methods of manufacture, and the development of single purpose tools for specific operations, the problem of unskilled labor has not been as complex as it might otherwise have been, experience proving that men, and also women, who had no previous knowledge of machine shop practice, have been equally capable with skilled mechanics in the operation of special machines. The question, however, is: What effect will this have on post-war manufacturing conditions? The knowledge acquired in the operation of machinery by the majority of those now working on munitions, will, when the "game" is over, be a factor that must be included in the problem of future readjustment. It must be conceded that large numbers of present shell workers will class themselves as, at least, operators when the war is over, and normal conditions again prevail. The lengthy duration of the war, and the mechanical experience they have gained, both in the operation of machines and the accurate manipulation of tools and gauges, may well fit many of them for a place in future mechanical activities.

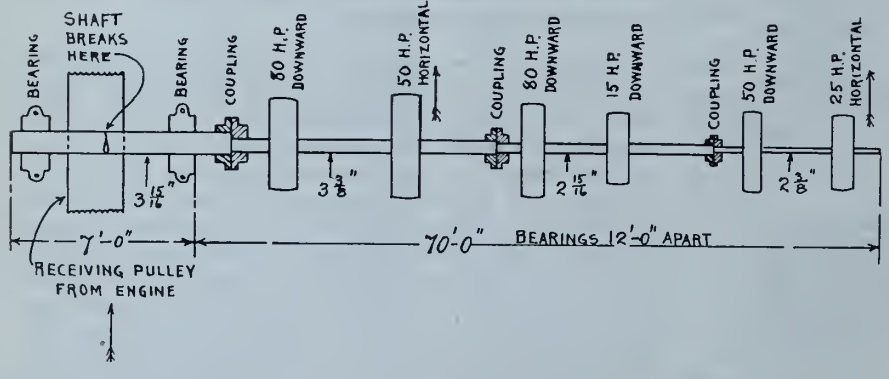
The Operators' Point of View

OVERCOMING TROUBLE WITH STEAM PIPE

By H. Westwood.

UNDER this heading in the January issue of the POWER HOUSE, there was an article by J. James, and also a sketch as to how he remedied the trouble. He states that after the load reached 280 amps. on each engine, they would start to race. Farther on in his article he states that when the steam gauge was attached to the pipe leading to one of the engines it was found they were not getting enough steam. If the engines raced it was steam pressure behind the piston that made them do so and the fact that he put a receiver 8 ft. x 12 ft. on the main steam line leading to the engines only acted as a gas bag or storage tank between the engines and boiler, and the engines do not get any more steam than they did before the change.

If the two engines in question could not get enough steam through a 5 in. pipe before the change, they will not get any more now. Assuming that the boiler pressure was 100 lbs. absolute, the receiver would hold approximately 7.3 lbs. of steam; now, if the engines were not getting enough steam before the change, they have only to use a little more than what is being supplied by the 5 in. pipe per minute and he would be up against the same conditions as far as the flow of steam through the 5 in. pipe is concerned, but his trouble regarding the see-sawing of the engines would be eliminated.



LAYOUT OF SHAFT WHICH GIVES TROUBLE THROUGH BREAKING.

It is just like running a gas engine plant from pressure producers, with a holder between the engines and producers. If the engines are using more gas than the producers are supplying to the holder, it will, in the course of a short while, become empty, and the engines would be sucking the gas from the producer, likewise the engines referred to by Mr. James would be wire drawing the steam.

A Similar Case

I had a case something similar to the one referred to, two high speed engines direct connected to 75 k.w. d.c. machines. The boiler pressure was 150 lbs. gauge and these engines were designed to operate on 90-lbs., so we had a reducing valve in the steam line. When the shop load had dropped off in the early evening, and I wished to put off the 400 k.w. generator and change on to the two high speed engines, there was difficulty in getting them on the board, I would start them up, adjust the voltage, and connect them to the board. They would operate in parallel with the large unit O.K., but as soon as I kicked the breaker on the large unit, one would try and pull all the load and out would go the breaker and likewise the second, because the load was too much for one. So I would put the large one on the board again till later in the evening when the load would be still lighter; then things would go all right.

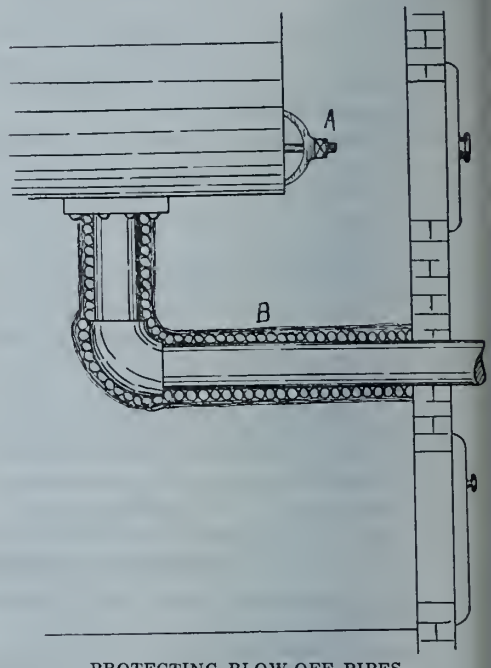
But one holiday there was not sufficient load to warrant putting on the larger unit and I left the two small ones to do the job. Whenever a load something near the rating of the machines hit them, they would see-saw and throw the breakers.

Indicating, these two engines showed that the steam was wire-drawn and a gauge attached to the steam pipe showed a drop in pressure, but a few turns on the nuts on the end of the spring of the reducing valve remedied the trouble.

PROTECTING BLOW-OFF PIPES

By J. E. Noble

CAST iron sleeves and file brick covers for protecting blow-off pipes are expensive and often bothersome, as they will persist in cracking and falling off at the



PROTECTING BLOW-OFF PIPES.

wrong time. A simple, inexpensive, and efficient covering, can be made as follows:—Cover the blow-off pipe from the boiler shell to the back wall with ⅜ in. asbestos rope, as shown at B. Make a mixture of two parts asbestos cement to one part fire clay and enough water to make it into a working plaster. Cover the asbestos rope with a coating of this mixture and the job is done. It is a good idea to cover hand hole bridges as at A, with a fire clay and asbestos mixture. If this is done the hand hole bolts will last for many months and the bridge for years.

TROUBLE WITH SHAFT BREAKING

By E. J.

A CORRESPONDENT submits the following account of trouble through breakage of a shaft. We have a line shaft about 70 ft. long, which delivers a total horse-power of approximately 300, taken off the various pulleys in the directions shown in sketch. The shaft is driven by ropes received by a pulley on a 7ft. length of 3 15-16 in. shaft. The other shafts are respectively 3⅜ in. x 30 ft., 2 15-16 in. x 25 ft. and 2⅜ in. x

15 ft., the bearings being about 12 ft. apart. The rope drive is from a corliss engine and revolves the shaft at 290 revs. per min. Considerable trouble has been experienced through the 3 15-16 in. shaft breaking in the centre of the pulley hub, and has been repeatedly checked up for alignment without any defect therein. Any suggestions by readers would be appreciated.

SHAFT TROUBLES

By John Ellethorn.

WHEN ammetic and voltmeter readings are taken on a line shaft and a heavy friction load is shown, it is usually stated by the investigator that the shaft is out of line and not leveled. In a recent test, in a laundry plant, where the friction load registered 45 per cent. of full load, the expert stated that the shaft was out of line. The shaft was re-lined, and bearings repaired, at considerable cost in time and money. New readings were taken, but the friction load had increased to 52 per cent. of full load.

The engineer, who was just an ordinary fairly intelligent sample of the profession, directed the attention of the investigator to the fact that the pull of the countershaft belts was practically all at one side of the line shaft, and that the belts from the countershafts to the machines was perfectly vertical, which meant a very tight belt.

In re-lining the shaft the cross belts, which were very short in some cases, and therefore had a high belt tension, had their tension increased, which would account for the extra seven per cent. All the cross belts were removed from the line shaft and a test showed a friction load of 5 per cent. only, a decrease of 35 per cent. from the first readings.

In many cases when a belt begins to slip, the man in charge will cut out a piece of the belt, thus tightening it up and incidentally increasing the friction and stretching the life out of the belt. The intelligent use of a good belt dressing would often save considerable work and prolong the life of the belt for many months.

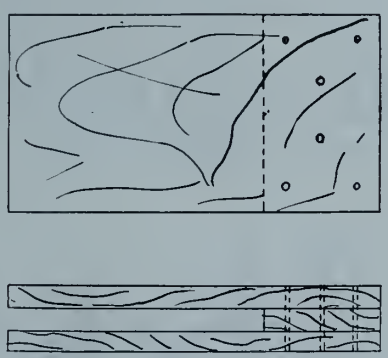
Many instruments are made to simplify the re-lining of shafts. Some are ingenious and useless and some are good if used intelligently and under proper conditions. If it is possible to have the power cut off from the shaft for a sufficient time to do the work, nothing can beat the lines, levels, plumb-bob, rule, and "gumption." I have seen men endeavoring to line a shaft while another shaft a few yards away and machines by the dozen were in full swing, causing such a vibration that no matter how tight the line was drawn, it would vibrate, while the "bubble" in the level would proceed to do a "tango" every time it was placed upon a hanger or bearing, and it was impossible to keep the plumb-bob from swinging. The use of one of the patented devices was no better. Therefore, do your line shaft lining when there is a shut down, Sunday, if no other day is available. If you shy at Sunday work, do it at night and sleep during the day. Of course, in some solidly built buildings the vibrations from one shaft to another would be next to nothing, but these later remarks refer to the other kind.

Make sure the fault is rightly located if the friction load is big. See that the hangers are not set too far apart for the diameter of the shaft and the load carried, that the diameter of the shaft is great enough to stand the pull at full load without springing, that the pull on the shaft, at the pulleys, is as close to the hangers as possible, that the pull is not all at one side of the line shaft, that as few belts as possible are vertical, and that the use of a good oil or grease is not forgotten.

PROTECTING BELT LACES FROM VERMIN

By J. E. McCormack

LAST summer the plant where the writer is employed was troubled with vermin which ate the leather lacing out of the rubber belts when machines were occasionally idle for a few days; even belts in regular use would sometimes have their lacing eaten during nights and Sundays. While experimenting



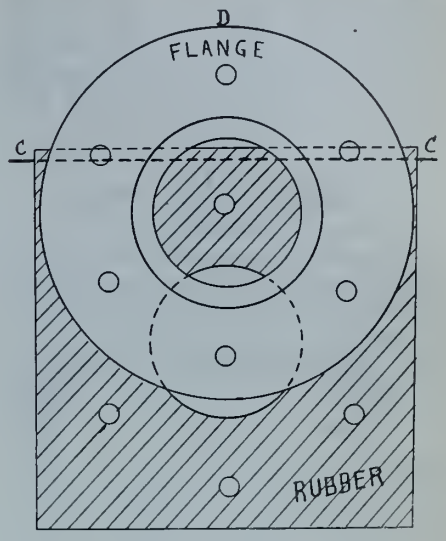
PROTECTING BELT LACES FROM VERMIN.

with various types of metal lacings to find one suitable for use on all of the belts, we protected the remaining leather lacings, when at rest, by placing over them shields made as per sketch, the dimensions varying with the size of the belt. The shields were made of 3 pieces of 1 in. board, nailed together and provided with a hole for a cord which was tied to the guard rail to prevent the shield from being carried to either pulley in case the belt was started up before the shield had been properly removed.

RENEWING GASKETS IN LARGE FLANGES

By John Port

MANY suggestions have been given for replacing rubber gaskets in large flangers, say 6 ins. and over, and a method I have used with success is shown in accompanying sketch. The bolts are removed and a steel wedge driven in at D, just far enough to get scraper in to clean the flange faces. A square of 1-16 in. sheet rubber, the diameter of the flange, is cut and the center hole and bolt holes cut out, and a piece of No. 14 soft copper wire is threaded along the top of the rubber, as at C C. The washer can now be drawn up from the bottom, or side opposite the wedge, without the washer



RENEWING GASKETS IN LARGE FLANGES.

falling down either on a vertical or horizontal pipe.

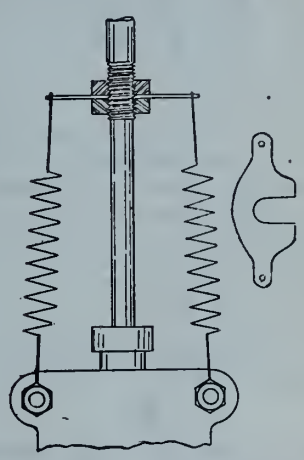
By using a soft wire, it is possible to keep the washer nearly flat; if a stiff wire is used the end of the washer would be heavily wrinkled. When the washer is in place the square ends are cut away. Some engineers advocate using a ring of rubber inside the bolt holes only thus saving considerable rubber. The idea is alright if care is used in tightening up the bolts, but it is easier on the flanges where a full sized gasket is used.

The wire can easily be removed from the flange washer by taking hold of it at C and holding the gasket at C. All that is needed is a gentle pull.

CURING AUXILIARY VALVE STEM TROUBLE

By W. D. B.

WHEN the auxiliary valve stem of a pump does not go through both ends of



CURING AUXILIARY VALVE STEM TROUBLE.

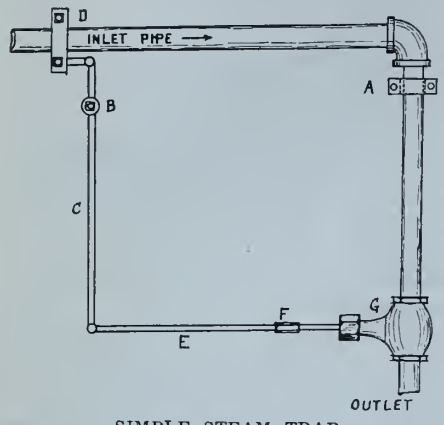
the steam chest the pressure on the inside end sometimes forces it out causing a short stroke. The writer found that an efficient method of overcoming this

was to cut a piece of sheet metal to shape A in sketch, which is then placed between the two nuts on valve stem nearest the steam chest. Springs are then connected as shown from the ends of A to any convenient parts such as the nuts on chest. Springs from old window blinds are quite suitable and are easily adjusted to balance steam pressure on inside end of valve stem.

SIMPLE STEAM TRAP

By L. U. N.

THE device shown in the accompanying sketch was devised by the writer for the purpose of performing the duties of



SIMPLE STEAM TRAP.

a steam trap, and gave excellent service during the period it was in use.

The inlet pipe is turned downward at elbow A and securely fastened to wall so that expansion in the pipe takes place in the opposite direction. At a distance of about 4 ft. along the inlet pipe, a bolt B is firmly fastened in the wall for the purpose of providing a hinge on which the lever C can oscillate. A collar D is clamped tightly on the inlet pipe and connected by a link to the upper end of lever C. The lower end of lever D is coupled up by rod E and right and left hand coupling F to spindle of globe valve G, the threads on the valve spindle having been carefully filed off so that it is free to move when operated by rod E.

In setting up the trap, the coupling F is adjusted so that valve G is open when cold, and after steam is turned on the increased temperature of the inlet pipe will cause it to expand away from A so that lever C closes the valve. The difference in temperature between the drain water and live steam can be carefully adjusted for when hot to suit the particular pressure in use, so that the presence of drip in the pipe will cool it sufficiently to contract its length and open valve G.

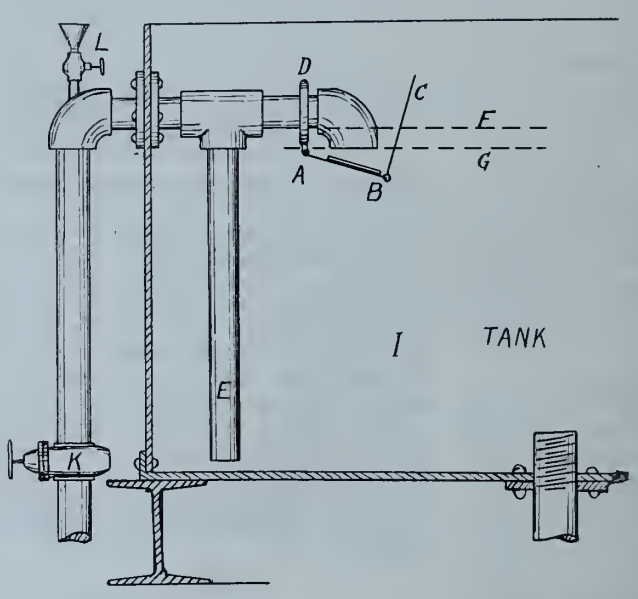
TANK SKIMMING AND EMPTYING DEVICE

By John Ellethorn

A LARGE water tank could only be emptied by allowing the water to run out through the pipe H. This pipe supplied a number of fixtures, and every time the tank was emptied sediment and other foreign matter would get into the taps causing considerable annoyance and work to get them into good working condition again. To overcome the trouble the pipe shown was connected to the regular overflow.

The end of pipe E reached to within one inch of the bottom of the tank. A strap D, was made to go around the pipe near the elbow, to this strap was fastened a disc of heavy galvanized sheet iron with a facing of leather or rubber in the center. The joint at A is made to be quite stiff, and the handle C is a piece of wire.

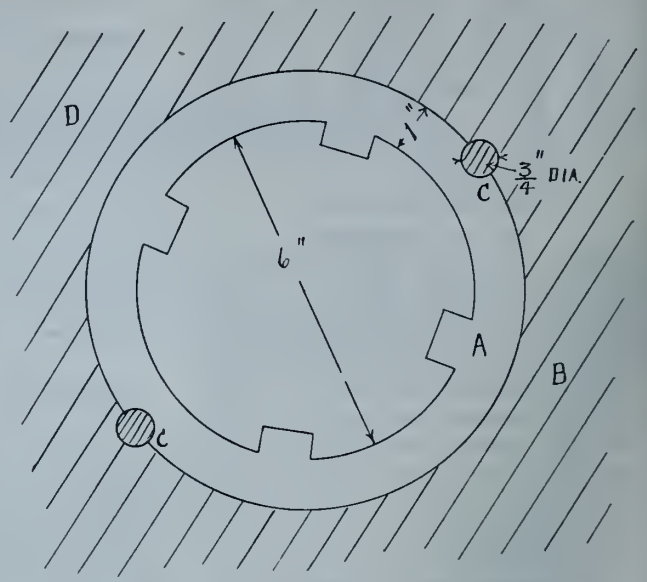
Much of the water in the tank came from the roof, bringing with it, leaves etc. These leaves would go from the tank through the overflow elbow, at the same time, part of the dirt at bottom of the tank would be drawn up through the pipe E. When the tank was receiving a large quantity of water, it would fill up to the level F, and then start to syphon until the water reached the level G, when the syphon would break.



TANK SKIMMING AND EMPTYING DEVICE.

When the tank required cleaning, a time was usually chosen when the tank was nearly empty so that water would not be wasted. The handle C was pulled up forcing the leather disc against the opening of the elbow. Valve K was closed and the pipe above it was filled with water through the valve L. Valve L was then closed and valve K opened quickly. This would start the syphon, men would get into the tank quickly, sweeping and stirring up the dirt which was all carried up pipe E and delivered to the sewer.

When the tank was emptied, handle C was again forced down. Elbow at the water line also acted as a trap from the sewer when the tank was full of water.



REPAIRING SEWAGE PUMP VALVES.

REPAIRING VALVES IN A SEWAGE PUMP

By John Port

IN a large sewage pump the valve parts A, were screwed into the valve chamber bed B. The ports were as shown so that pieces of cloth and other material could pass through them. The valve covers were made of brass and hinged to a lug at D. In the course of time the parts A became loose and several of them were driven right through the bed B. The only way to fit new valves was to send the pump to the factory as the old threads on the bed were worn out. This would take up considerable time and the sewage tank should be pumped out every 48 hours.

Fine copper wire was turned or tied around the ports A, and they were screwed into place, next two holes were drilled at opposite sides and tapped out for ⅜ bolts at C. C. Two bolts for each valve were made with a slight taper and a very tight fit, and were screwed into the holes as far as possible without twisting them apart, and then sawed off level with the top of the port, the eight valves in the pump were treated in the same way. The pump has been in operation, for several months and is O.K. yet

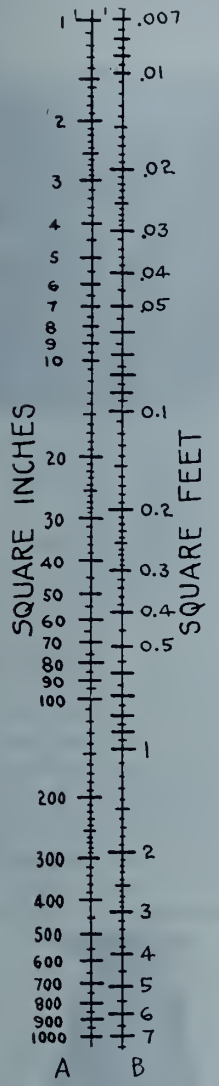
This job saved the owners at least $40, and a possible lawsuit if the sewage had

been allowed to run free while new valves were being made.

CONVERTING SQ. INCHES INTO SQ. FEET

By N. G. Near

ENGINEERS will find this scale handy for quickly converting square inches into square feet, or vice versa. Simply glance across from one column to the other and the answer is immediately found. For example:—How many square feet are there in 300 sq. inches? Find the 300 in column A and glance across to column B. The answer is—practically 2.1 sq. ft. Again, how many square inches are there in 2 sq. ft.?



Find the 2 in column B and glance across to column A. The answer is, of course, 288, but we would call it roughly 290.

The first operation is the one that is most difficult to perform "longhand." Multiplying generally comes more easily, and so the second operation would perhaps be used more often.

CORROSION AND FOAMING

PITTING and corrosion in boilers are frequently due to magnesium chloride in waters and less often to calcium chloride. Either of these salts is very pernicious, in that on hydrolysis it produces free hydrochloric acid. This action is, however, in large measure counteracted when the temporary hardness runs high. In some localities waters are rather high in nitrates, and such waters are always highly corrosive. Large amounts of sodium chloride also tend to make waters corrosive. Some waters that are very low in their mineral content produce corrosion, especially at the feed-water intake, owing to a large amount of dissolved oxygen and free carbonic acid. Peaty waters are harmful to boilers, by reason of the vegetable acids which they contain. Waters containing a free mineral acid are particularly harmful.

Waters which contain large amounts of alkali salts, especially sodium carbonate and sodium chloride, have a tendency to foam. Suspended matter of any kind increases the foaming tendency, and for this reason frequently muddy waters produce this effect, which disappears after the water supply has become clear by sedimentation. Waters low in mineral content but high in organic matter, though perfectly clear, may also be troublesome, because a part of the organic matter precipitates. The bad effect of mineral or vegetable oils finding their way into the boiler feed water is well understood.

One point that should be emphasized in this connection is that sodium salts, in most cases sodium sulphate, are augumented in the softening process. If a water contains magnesium sulphate or calcium sulphate, two important salts in bad boiler waters, they will require soda ash and there will be put into the softened water 142 lb. of sulphate of soda for every 106 lb. of soda ash used. Lime removes the temporary hardness from water without introducing other salts in exchange, while soda ash introduces a corresponding amount of soluble alkali salts. Some waters are so high in initial alkali salts that they will not stand a further addition from the soda ash used as softener without producing serious foaming. In such cases barium hydroxide can be used as substitute for soda ash, although its high cost limits its use to emergency. One other objection lies in the poisonous action of all barium salts that are soluble.

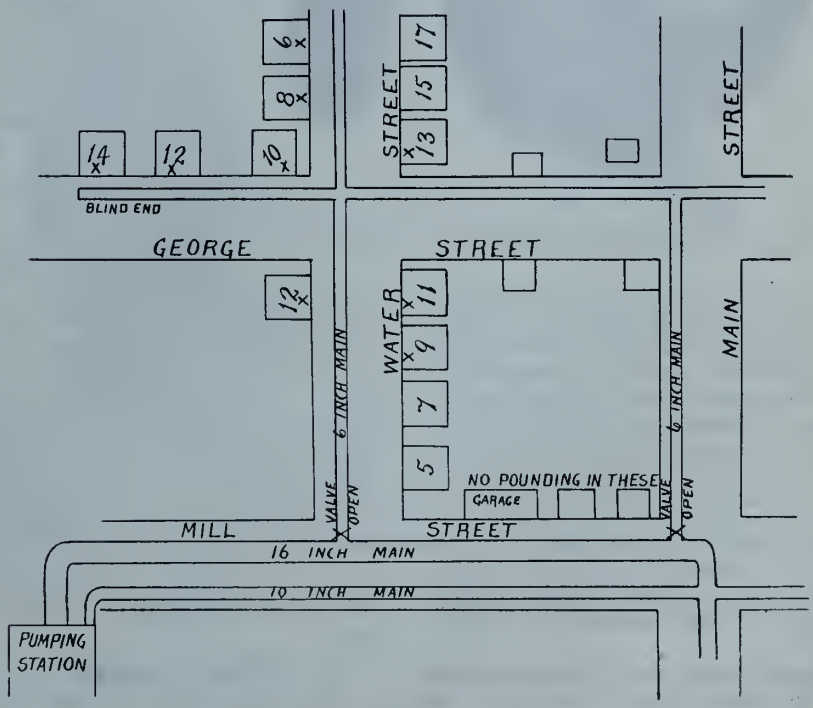
From what has been said relative to the effect of large amounts of alkali salts on waters, it is evident that one good result to be obtained from chemical control in water softening is the prevention of an overfeed of soda ash, as any large excess of this chemical will produce a foaming water. The only methods of combating foaming waters appears to lie in frequent blowing off and washing out the boilers and along lines of improved boiler construction.—A.S.M.E. Paper.

POUNDING IN PIPES OF WATER-WORKS SYSTEM

By W. Carnegie.

THE accompanying diagram illustrates the mains of a water service. Recently, consumers in houses marked by a X have been complaining of a pounding in the water pipes in their houses. The pounding is not continuous and generally commences in the evening. The writer is quite at a loss to account for this trouble. In house No. 7, which is only a short distance from the pump-house the use of an electric tester failed to detect the strokes of the pump, while in No. 9 house the noise is very bad. In house No. 11 the noise is barely audible while in No. 13 it is very bad at times, also Nos. 10, 12, 14, 8 and 6.

Readers who have had experience of similar occurrences are invited to express opinions and offer suggestions to improve the situation.



POUNDING IN PIPES OF WATER WORKS SYSTEM.

Steam Power Plant Auxiliaries

OIL SEPARATORS—I.

IN addition to removing moisture from live steam, separators have an equally important duty to perform in the removal of oil from exhaust steam before it is condensed and used for boiler-feed and other purposes. Where exhaust steam is used for heating, drying, and other allied purposes, the necessity for having it dry is just as strong from an economic point of view as in the case of live steam, as definite observations have proven that condensation in any kind of cylinder or receptacle is more rapid when the steam is wet than when it is initially dry. Although, therefore, an oil separator on an exhaust pipe does not have to handle conditions involving mechanical strains, etc., such as arise from slugs of water coming over with steam from the boilers, it must be so designed as to extract both moisture and oil at comparatively low pressures with correspondingly reduced velocities.

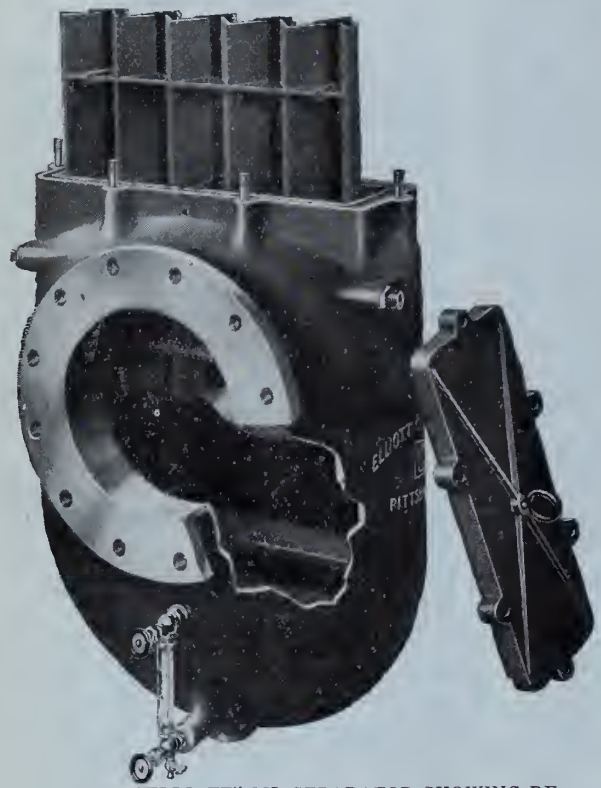


FIG. 1. "ELLIOTT" OIL SEPARATOR SHOWING REMOVAL OF BAFFLE PLATE FOR CLEANING.

Exhaust steam when properly purified and free from oil and moisture, is a prolific source of economy, containing, as it does, 80 to 90 per cent. as much heat as was originally put into the live steam. The condensed returns make ideal boiler feed when free from oil since they possess no scale-making impurities. The evil effects of oil in exhaust steam are well understood. If used for heating, the oil in exhaust steam will in time coat the inner surfaces of the apparatus so as to reduce their efficiency, while condensed returns containing oil should on no account be used for feed-water, as its action on the internal heating surfaces is that of a non-conductor, causing overheating of plates, tubes, and flues, with ultimate bulging, collapsing, or other failure.

Cylinder oil employed for the lubrication of engines and similar steam-operated mechanism, appears in the exhaust steam in two forms, free oil and emulsified oil, partly carried as particles in the steam current and partly mixed with the condensation. The principles employed in the mechanical separation of oil and moisture involve application of the laws of inertia and momentum. Various types of oil separators are in existence, which embody to a greater or less extent three principal features, viz., decrease of velocity, change of direction, and ample reservoir capacity. The first of these is obtained by making the separator head or chamber larger than the pipe, so that the entering steam has its velocity reduced to an extent which allows the force of gravity to exert its influence in withdrawing oil from the steam. The second feature plays a highly important part in nearly all separators and is generally accomplished by baffles, spirals, etc., which produce a whip-like action on the steam and cause the particles of oil and moisture to impinge on variously shaped baffles down which they travel to the receiver space. In some cases water spray is played on the plates to facilitate separation of the oil.

Elliott Separators

The removal of oil from exhaust steam on its way to a condenser presents difficulties that do not exist with non-condensing systems, due to the high velocity of steam resulting from large volume and low pressure.

Fig. 1 illustrates an Elliott type P separator, specially suited for vacuum work. The baffles consist of a double row of V-shaped plates, and the steam, in order to pass through, must make a number of short quick turns, this action effecting the removal of all the oil and entrainment. The first row of plates merely directs the steam at the proper angle against the second row of baffles, which in turn throw the particles of oil back into the recess angles of the first row, thus putting the oil completely out of the path of the steam. If the steam is dry, the baffles are kept wet with jets of water from a spray pipe, connection for which is shown on side of separator, which arrangement not only assists in the separation of the oil from the steam, but in a measure prevents the plates from becoming gummed up in continuous use. As the cover of the separator is removable, the baffle plates

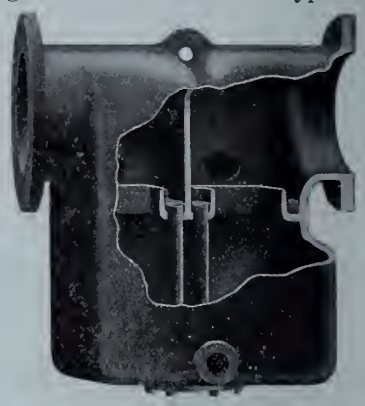


FIG. 2. "HOPPES" OIL ELIMINATOR SHOWING SEPARATING TROUGHS AND LARGE PASSAGES

FIG. 3. "ANDERSON" VERTICAL OIL SEPARATOR SHOWING SPIRAL VANES AND BAFFLE ON OUTLET

can be taken out and cleaned when necessary without breaking connections. These separators are part of the line manufactured by the Elliott Co., Pittsburgh, Pa.

Hoppes Oil Eliminator

In this apparatus special effort has been made to avoid any obstruction to the flow of steam from the engine to the condenser and all possibility of obstruction has been avoided as much as possible. With this end in view, the area of the ports exceeds one and one-half times that of the pipe, small or tortuous passages being conspicuously absent The separation of the oil is thoroughly accomplished by troughs, partly filled with water, which surround both inlet and outlet ports. The reduced velocity and large contact surface of the walls facilitate the separation of the entrained oil, which is also intercepted by the trough surrounding the inlet port, and is thus prevented from being sprayed into the steam chamber by the main current which in its downward plunge carries all suspended oil to the bottom, where it is separated by contact with the surface of the contained water and retained. The outlet port is surrounded by a second

FIG. 4. HORIZONTAL TYPE OF "ANDERSON" SEPARATOR SHOWING RECEIVER CAPACITY

water trough, which cuts off any oil which may tend to creep out on the wall surfaces. An overflow pipe from each trough carries the oil and surplus water to the bottom of the separator, from which another overflow pipe is connected to a receiver or trap.

These eliminators are built in a full range of sizes, horizontal, vertical and right angle, in both cast iron and steel shells by the Hoppes Mfg. Co., Springfield, O.

Anderson Oil Separators

The employment of centrifugal force through the medium of suitably disposed spiral vanes, etc., is one of the principal features of the Anderson oil separator. A cone-shaped cap in the head guides the steam with minimum friction through the spiral vanes shown in transparent view, Fig. 3; these vanes imparting a centrifugal motion to the steam which throws the oil and moisture to the outside of the case, whence it passes down into the receiving chamber. This receiving chamber, which forms the lower part of the casing, contains the outlet opening which is provided with a baffle ring to prevent the oil and moisture from again intermingling with the steam. Both horizontal and vertical types are built in sizes ranging from 1½ in. to 12 in. by the V. D. Anderson Co., Cleveland, O.

Hine Eliminator

Large area of passages, reversal of

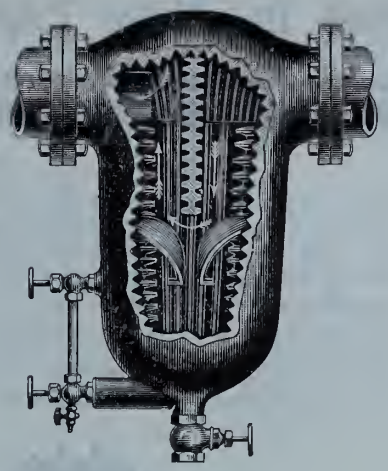


FIG. 5. HORIZONTAL "HINE" ELIMINATOR.

direction and the use of corrugated surfaces for catching the entrained oil and moisture are features of the Hine Eliminator which is illustrated in Figs. 5 and 6. The action in each case is similar. Entering the inlet of the horizontal type, the steam impacts against the central baffle, proceeding thence over and under, in such a manner that the centrifugal force brought into play causes the oil and moisture to be deposited on the adjacent grooved surfaces. Separated matter drains to the bottom down suitably arranged grooves, grooved baffles being placed over the receiver space to maintain separation of drainage. The vertical type, Fig. 6, causes the steam to make two complete reversals in passing over the corrugated surfaces. Separated mat-

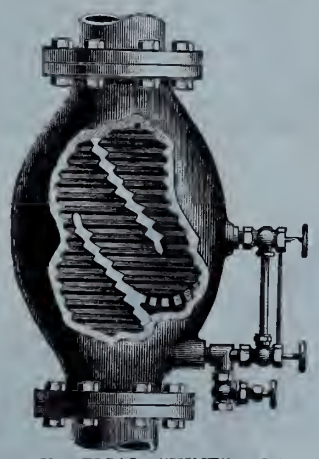


FIG. 6. VERTICAL "HINE" ELIMINATOR.

ter drains into a pocket at the lower right, as shown, whence it passes to receiver or trap. J. L. Robertson & Sons, New York, are the makers of this device.

BOILER FAILURES AND LOSSES DUE TO SCALE

SO much has already been written about scale, corrosion, priming, etc., that it is somewhat disconcerting to note that reports show an increased number of dangerous defects in boilers from year to year due to these causes. A prominent boiler inspector says, "If I were asked to state the most frequent cause of steam boiler explosions, meaning the tearing asunder of any part of a boiler by force of steam pressure, I would unhesitatingly say it is scale."

If the water in a boiler comes in direct contact with the hot plates or tubes, these, if free from scale, remain practically at the same temperature as the water. If there be a greater or less thickness of scale on the plates, however, the scale acts as a very poor conductor of heat, and the iron plates and tubes may reach a plastic temperature because the water does not absorb the heat from them, and they may finally fail, due to the force of the steam pressure in the boiler.

Aside from the possible dangerous condition of a "scaly" boiler, the fact must be borne in mind that scale means fuel waste. Authorities differ on the exact amount of such waste, but a general average of experimental evidence on this point is shown in the following:

Thickness of scale, in. 1-64, 1-32, 1-16, ⅛, ¼, ½, ¾.

Waste of fuel, per cent. 2, 4, 9, 18, 38, 60, 90.

It is undoubtedly true that the physical and chemical characteristics of the scale formed have something to do with its nonconducting properties, and it is believed to be quite unlikely that the extreme losses shown would be met with in practice.

There are other scale troubles than those enumerated above. Scale may clog feed pipes and water and steam gauge connections, and prevent the complete closing of valves. An instance is recorded where the blow-off valve was presumed to be closed completely, but had a piece of scale under it; the water slowly leaked out, and this fact, necessarily coupled with a lack of proper attention to the boiler caused the plates and tubes of the boiler to be burned to a proper condition for the junk heap.

These statements and the general mass of evidence now extant in power-plant literature show that it is to the best interests of owners and operators to keep boilers practically free from scale for reasons of safety, economy of fuel, saving of labor, and durability.—A.S.M.E.

KEROSENE A REMEDY FOR SCALE TROUBLES

THE use of kerosene oil as a remedy for scale troubles has had many advocates, and its success, while undoubtedly due to mechanical action alone in removing scale and preventing its formation, depends upon conditions and upon the user. To be reasonably effective in any case, the kerosene should be put in after the boiler is emptied and washed, and the refilling of the boiler be slowly done from the bottom. It is useless to pump the kerosene in with the feed water, for, like the heavier oils, it may tend to form a nonconducting film over the heating surfaces that will introduce an element of danger in operation.

Progress in New Equipment

COMBINED STEAM TURBINE AND CENTRIFUGAL BOILER FEED PUMP

THE tendency towards displacement of the reciprocating boiler feed pump by the centrifugal pump furnishes a good example of the necessity resting upon manufacturers of machinery for sustained technical development. Since it must handle a comparatively small amount of water against a relatively great head, the centrifugal boiler feeder should be fitted with small diameter impellers running at high speed. It is therefore well adapted for steam turbine drive. Fig. 1 shows an early steam turbine-driven boiler feeder built in 1910 by the De Laval Steam Turbine Co. The two-stage pump has a capacity of 1,600 gals. per minute against 700 ft. head at 2,800 r.p.m., and upon test gave an efficiency of 60 per cent. The pump is entirely independent of the turbine, a coupling being interposed between the pump shaft and the turbine shaft, and it could therefore have been driven just as well by electric motor or by rope or belt as by a steam turbine.

The unit, however, realized the advantages peculiar to the centrifugal boiler feeder, viz., reliable and uninterrupted service with little, and often unskilled attention, absence of pulsation, shock, water hammer, vibration, or over pressure in pipe lines, elimination of relief valves, suitability for use with automatic boiler feed regulators acting independently at each boiler and with feed water meters, close governing, either by speed governors or by pressure governors, freedom from injury by overloading, lightness and compactness, accessibility, elimination of valves, packings, sliding surfaces and air chambers, small upkeep and attendance expense due to simplicity and few wearing parts, lower cost of maintenance of piping system, small consumption of oil, efficiency, and in the turbine-driven type, ability to use superheated steam or to run upon either high or low pressure steam, oil-free exhaust, and independence of the main units.

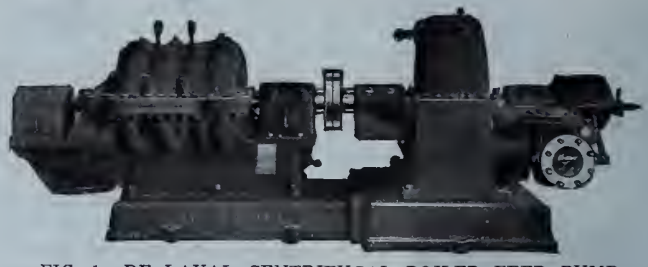


FIG. 1. DE LAVAL CENTRIFUGAL BOILER FEED PUMP COUPLED TO INDEPENDENT TURBINE.

A still further development in the direction of compactness and simplicity is shown by Figs. 4 and 5, illustrating a 3,000 horse-power, two-stage centrifugal boiler feeder combined in one casing and on one shaft with a velocity-stage steam turbine. This unit, which also has been developed by the De Laval Steam Turbine Co., weighs, it is claimed, about one-tenth as much as a duplex reciprocating pump of the same delivery and occupies only about one-eighth as much floor space and one-fifteenth as much cubical space.

The pump end contains two single-suction impelelrs cast from a special bronze and carefully finished to exact contours. Two impellers are used for pressures up to 200 lbs. per sq. in., and three impellers for higher pressures. Single-stage boiler feed pumps have been built, but two or three stages are preferable because of the much longer life of the impellers at slower speeds. Each impeller discharges into a volute chamber by means of which the velocity in the water as it leaves the impeller is converted into pressure before the water is led to the eye of the succeeding impeller. This means of energy conversion is claimed to be superior to the use of diffusion rings as it is efficient over a wider range of delivery, and more important still, does not involve the use of small and sharp parts like diffusion blades, which are subject to rapid erosion.

The pump is hydraulically balanced and only one pair of labyrinth rings surrounding the suction opening is required for each impeller except the last, which has two sets of rings. The whole back of the impeller is subjected to a pressure equal to that existing at the periphery of the impeller, the same pressure acting on the front of the impeller, except for the area of the circle enclosed by the labyrinth ring about the suction opening. The last impeller, that is the one from which the water is finally dis-

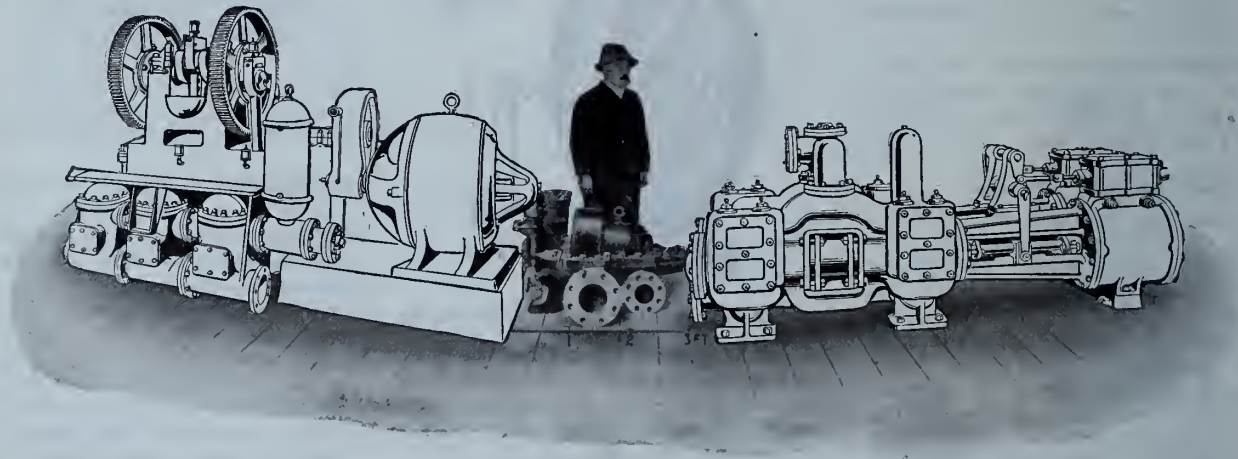


FIG. 2. COMPARATIVE CAPACITY DIAGRAM SHOWING STEAM TURBINE-DRIVEN BOILER FEED PUMP, DUPLEX STEAM PUMP, AND TRIPLEX MOTOR-DRIVEN PUMP.

charged, is equipped with two sets of wearing rings, one on the suction side and one on the reverse side of the web. As some water from the discharge of this impeller will leak between the wearing rings into the space back of the web, this impeller would be equally as unbalanced as the other impellers in the pump if there were no escape for the leakage water. To provide for diminishing the pressure in this balancing space as much as may be required to bring the whole series of impellers into balance, a leakage outlet is provided from which water can be conducted back to the suction of the first impeller.

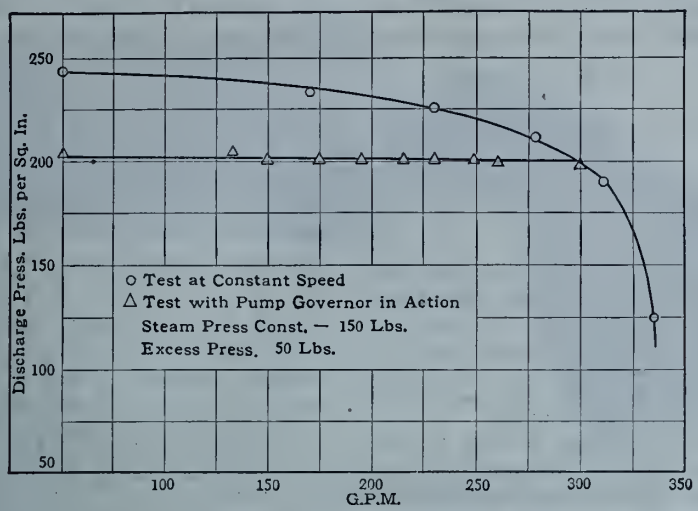


FIG. 3. HEAD DELIVERY CHARACTERISTIC OF DE LAVAL TURBINE-DRIVEN BOILER FEED PUMP UNDER CONTROL OF SPEED AND PRESSURE GOVERNORS RESPECTIVELY.

The outlet leakage takes place between two collars, one attached to the casing and the other carried on the shaft. When the shaft moves towards the discharge end of the pump this escape is closed off and the pressure builds up in the balancing chamber. If the shaft, on the other hand, moves toward the suction, this escape passage is opened wider, allowing the pressure in the balancing chamber to fall and at the same time the inleakage between the labyrinth wearing rings is decreased. By this means direct and positive balancing within very close limits is secured with leakage of but a small amount of water. The so-called natural balancing secured by the use of double suction impellers in a multi-stage pump is in comparison uncertain and imperfect, besides involving an extra long shaft, heavier impellers, and two pairs of wearing rings to each impeller.

The labyrinth wearing rings are readily renewable, the stationary ring of each pair being held in seat in the casing and the rotating ring being screwed upon the impeller. The reduction of leakage secured by the use of intermeshing labyrinth rings is highly important for securing high efficiency in pumps of comparatively small delivery. With the labyrinth type of ring the leakage path is so tortuous that very little water escapes even at high heads, although ample clearance is provided to take up expansion and contraction due to changes in temperature.

The suction end of the pump is adjacent to the turbine, and the shaft packing between the turbine and pump chambers is hence subjected to turbine exhaust pressure on one side and the suction pressure on the other. A simple packing is therefore sufficient, and in any case, any small leakage of steam in one direction or of water in the other does no harm. As the leakage space adjacent to the balancing chamber at the discharge end of the pump is connected back to the pump suction, the packing about the shaft is subjected only to suction pressure. Aside from the intermediate packing already mentioned, there is only one steam packing, which is subjected to exhaust pressure.

The steam end of the unit consists of a velocity- stage turbine with either two or three rows of moving buckets, according to the steam economy desired. The nozzles can be proportioned for either high pressure steam exhausting to feed heater or to condenser or for low pressure steam exhausting to condenser, or the unit can be made interchangeable, thus permitting of a great degree of flexibility in plant design. Where the exhaust steam from the boiler feeder is consumed in heating feed water, the thermal efficiency of the turbine- driven boiler feeds is greater than that of a boiler feeder driven by electric motor, or even than that of the main unit itself.

The unit is in some instances fitted with a speed governor mounted upon the end of the shaft, and when running at constant speed, the head varies with the delivery, as shown by the curved characteristic in the accompanying chart. As will be seen, the rise in pressure at reduced capacity is not excessive. Ordinarily, however, a pump governor controlled by the pressure at some point in the feed line near the boilers is employed to control the speed, giving a practically uniform pressure at all deliveries, as shown by the lower and straight line in the chart. In case of failure of the pressure governor to operate. the control of the unit is automatically taken over by the speed governor.

However, to provide against any possibility of racing, an emergency governor is also fitted. This consists of a pin contained within a hole bored diametrically through the shaft. This pin is held by a spring from flying out under the influence of centrifugal force. When the speed reaches a certain point, the spring is compressed so that the pin strikes a trip, releasing another spring by which the governor valve is closed at once and completely. Racing and excessive over-pressure are therefore impossible. The normal speeds of these pumps vary from 1,800 to 3,500 r.p.m., according to pressure and capacity, and

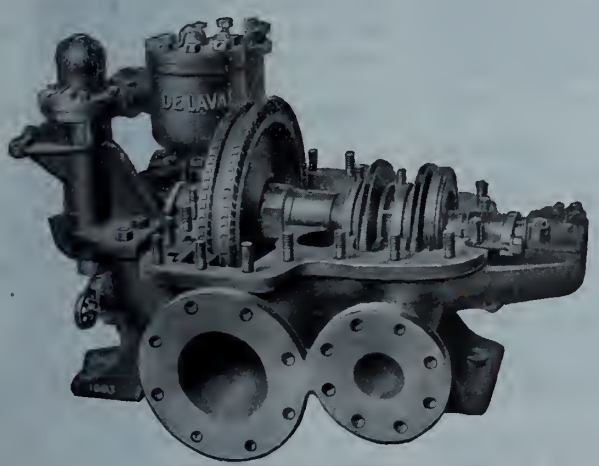


FIG. 4. DE LAVAL COMBINED TURBINE-DRIVEN BOILER FEED PUMP. CAPACITY 3,000 BOILER-HOUSE POWER.

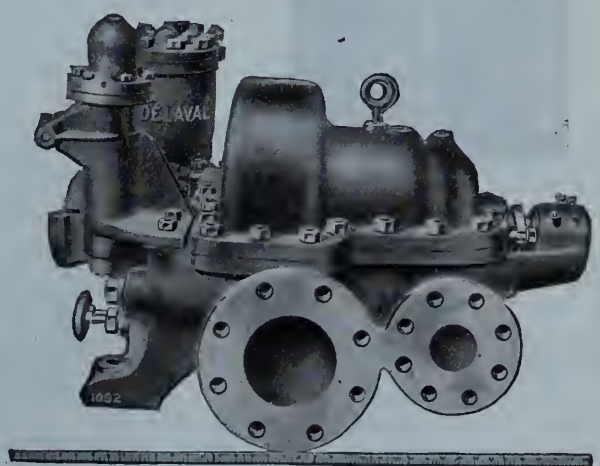


FIG. 5. DE LAVAL COMBINED TURBINE-DRIVEN BOILER FEED PUMP WITH CASING COVER REMOVED.

due to the heavy shafts employed are far below the critical speeds.

The bearings are of the straight, split ring-oiled type, and like other parts subject to wear, such as the pump impellers, turbine rotor labyrinth rings, and governor valves, are built to a limit-gauge basis, so that they are all interchangeable. The entire rotating members and all wearing parts, with the exception of the governor valve, are accessible for inspection or removal upon lifting the casing cover and taking off the bearing caps, all of which can be done without breaking steam or water pipe connections.

In specifying the capacity of boiler feeders ,the temperature of the water to be pumped should always be stated, as the capacity is nearly 50 per cent. greater with water at 75 deg. F. than with water at 210 deg. F. For the same reason, capacity and efficiency tests of a pump should be carried out with water at the temperature at which it will be received by the pump when in actual service. The De Laval Steam Turbine Co. inform us that they are equipped to make such tests on all pumps that it builds.

CELL MOUNTING OIL CIRCUIT BREAKER

A COMPLETE line of oil circuit breakers has been recently developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, two of which, types E6 and E7, range in capacities from 300 to 1,200 amps. at 23,000 volts, and from 1,600 to 2,000 amps. at 16,500 volts. The former is for cell mounting, as illustrated in the accompanying engraving, while the latter is for wall or pipe mounting. All

SHELL MOUNTING OIL CIRCUIT BREAKER.

steel construction is used, thus providing apparatus which is exceptionally compact for its rupturing capacity, which ranges from 35,000 to 40,000 kva. at maximum rated voltage, with proportionately higher capacities for lower voltages.

For cell mounting, a novel feature is the holding of the steel base of each pole unit in channel irons built into the cell walls, whereby the units are easily slid in and out; the single pole solenoid complete with its mechanism, is mounted on top of the cell structure. Accelerating springs are provided to break the arc as quickly as possible after the breaker starts to operate, an adjustable air cylinder dash pot being furnished to take up the shock of the moving parts.

All breakers are able to clear the system of a short-circuit up to its rated capacity three times without attention to circuits, a test of sixteen breaks being made on a 25,000 kva., 23,000 volt turbo-generator circuit, without the breaker being opened for change of arcs.

BOILER TROUBLES CAUSED BY CORROSION

SCALE is not the only source of boiler trouble caused by water, the trouble due to corrosion of sheets, tubes, stays, etc., being in some cases more acute than ever occurs with scale. Carbonic acid gas, occluded oxygen, and sodium and magnesium chlorides are the most frequent offenders in this respect, and the chlorides are so difficult to remove from the water as to make the cost of removal practically prohibitive.

Corrosion due to the chloride ingredients is particularly destructive to steel boiler tubes, hot-water piping, and brass-seated valves. Galvanized steel pipe is not immune to the action of these salts, because any defect in the zinc coating permits the setting up of local galvanic action between the zinc and steel in the presence of salt water, with the consequent rapid destruction of the zinc coating. Water which contains as much as five hundred parts per million of either or both of these chlorides, as is sometimes the case with deep well water, may be regarded, especially when hot, as a water destructive to steel pipe and fittings.

In the writers' experience several steel deep-well casings have corroded through after having been placed but a few years, and permitted salt water from another stratum to enter the wells and practically ruin their waters for boiler purposes and hot-water lines. The remedy in a number of such cases has been to place another casing inside the original one, using genuine wrought-iron pipe, and at the same time pack off the salt water effectively by means of hemp-rope coils placed on the new casing. Genuine wrought-iron pipe and fittings will unquestionably outlast any steel pipe under such conditions.

Waters are frequently both scale-forming and corrosive; usually, if a water has a corrosive tendency there will be scale formation to a greater or less extent. Caustic or carbonate alkalies or caustic lime act as neutralizing agents for corrosive ingredients, but these reagents must be carefully handled or the scale-forming matter will be greatly increased, and their use should be confined to treatment of the water outside the boiler if possible.

Owing to the ordinary varying pressures on different parts of the boiler, especially when blowing off rapidly under high steam pressure, as is sometimes done, the mechanical movement of the sheets is likely to assist corrosion to complete a failure of the boiler, in that, in some cases, sheets bulge and seams open, allowing water or steam to leak through and cause abrasive action which supplements the corrosive action and is sometimes mistaken therefor.

Cases of corrosion in fire-tube boilers which have come within the observation of the writers would indicate the corrosive action to be variable in character; in some cases the pits were small depressions; in others, large, cup-shaped hollows, and in one instance the main corrosive action had taken place at about the average height of the water line along the shell; the shell was eaten through completely and a leak started while the boiler was under 150 lb. steam pressure. Soon afterwards, when this boiler was removed from its setting and discarded, it was easily possible to break through the shell with a 2-lb. hammer along the line mentioned. Official inspection of the boiler had been made by the insurance company inspector but a few weeks before, and no defect was indicated in the report concerning it. This practical illustration, which is but one in line with many referred to from time to time in technical papers, of the impossibility of thoroughly inspecting a fire-tube boiler without the removal of at least a part of the flues, is a most important indication of the desirability of careful attention to the purification of boiler water.

It is true that the safety feature is of much less moment with water-tube boilers than with fire-tube boilers, but the price of water-tube boilers is necessarily higher for a given capacity, and under all-day operating conditions their increased efficiency over fire-tube boilers is not of consequence for small power plants up to about 600 h.p. With bad water the water-tube has the advantage, in all but a few types, of being readily inspected. Someone has estimated that three times the labor is required to clean a foul water-tube boiler than is necessary for a fire-tube boiler of the same capacity, but the fact should be emphasized, nevertheless, that one can thoroughly clean a badly "scaled" water-tube boiler, but he cannot as thoroughly clean a badly "scaled" fire-tube without using an extraordinary method and incurring extra expense.—A.S.M.E. paper.

PRODUCTION OF COMBUSTION OF COAL

When carbon burns completely the product is carbon dioxide (CO_2); when it is partly burned the product is carbon monoxide (CO). If more oxygen is supplied, carbon monoxide can be burned to carbon dioxide. The hydrogen of coal burns to water vapor, which condenses to water when cooled to atmospheric temperature. The furnace gases therefore consist mainly of oxygen (O_2), nitrogen (N_2), carbon dioxide (CO_2), and carbon monoxide (CO). Besides these there may be found near the surface of fuel bed a small quantity of hydrogen (H_2), methane (CH_4), and unsaturated hydrocarbons. By analyzing the gases at successive points in a furnace the progress of combustion can be studied.

THE BULLDOG WINS

When it comes to staying on a hard job there is no cleaner like the old reliable "BULLDOG."

The "BULLDOG" Cleaner for bent tubes — operated by water.

Another Cleaner Fell Down

In a certain plant in Missouri the only day that a boiler could be spared for cleaning was on Sundays when the load on the plant was light. The engineer tried in vain to keep the boilers clean by working hard all day Sunday, but the best he could accomplish with the cleaner he had was an average of ten tubes per Sunday. This was far from enough, as the condition of his boilers was getting worse and worse.

Then in some manner he heard of our "Bulldog" cleaner (perhaps through an ad. similar to this). After an investigation a "Bulldog" was ordered. The first Sunday's work with the "Bulldog" resulted in the removal of more than 2,000 lb. of scale from a 300-hp. Heine Boiler and the boiler was entirely cleaned—ready to go back in the line—at six o'clock in the evening. Boiler cleaning, even under the most favorable conditions, is a hard proposition, but the "Bulldog" Cleaner goes a long way toward making the task less difficult. It has no rival either for speed or endurance, which are the important factors when a boiler is down for cleaning.

Catalog "H" describes the "Bulldog" Cleaner, also the "Victor" and other types. Send now for a copy and have it on hand when it is wanted. It's yours for the askin'.

LIBERTY MANUFACTURING COMPANY

6904 Susquehanna Street **Pittsburgh, Pennsylvania**

Just as the "Bulldog" is the King of the water operated tube cleaner, the "Victor" is the Premier of the tube cleaner operated by air or steam. The "Victor" shown below is made in all sizes suitable for all type of boilers.

The "VICTOR" Cleaner —for straight tubes — operated by air or steam.

The illustration below shows the result of 3-in. "Bulldog's" battle with scale. This "Bulldog" run continuously for 480 hours without any repairs, except drill points.

If any advertisement interests you, tear it out now and place with letters to be answered.

Projects and Developments

TRADE GOSSIP

E. T. Austin has been appointed manager of the Belleville Waterworks Department in succession to J. W. Evans.

Montreal, Que.—The Riordon Pulp & Paper Co., contemplate developing water powers at Hawkesbury and Merritton, Ont., aggregating 30,000 h.p.

Prince Rupert, B.C.—The City Council are considering the question of installing a cold storage plant to aid the fishing industry.

Thomas J. Gerry who for over twenty-five years was connected with the Dodge Manufacturing Co., Toronto, as traveller died at his home in Toronto recently.

Sudbury, Ont.—The Town Council propose to spend $46,000 for a stand pipe and auxiliary water main, and $2,500 for alterations to the lake sewer pumping station.

Yorkton, Sask.—Tenders will be received until April 30 for one 350-400 b.h.p., combined Diesel electric unit. Specifications may be obtained from F. J. Pilkington, Town Clerk.

Redcliff, Alta.—An expenditure of $30,000 is contemplated for alterations in the present pumping station and installation of adequate machinery. A by-law will be submitted to ratepayers.

Sudbury, Ont.—On April 30 a by-law will be voted on by the ratepayers to sanction an expenditure of $46,000 for stand pipe and auxiliary main, and $2,500 for alterations to lake sewer pumping station. W. J. Ross, town clerk.

Toronto, Ont.—The Hydro-Electric Commission contemplate a further development of 1,500 h.p. at Eugenia Falls and 2,000 h.p. at Big Chute. The proposed expenditure for Eugenia Falls extension is placed at $217,897, and that for the Severn River extension $121,238.

The Bawden Pump Co. has been incorporated at Toronto, with a capital of $40,000, to carry on the business of engineers and founders, including the manufacture of pumps of all kinds at Toronto. The incorporators are: G. H. Sedgewick, James Aitchison, and Duncan McArthur, all of Toronto.

The Turbine Equipment Co., Toronto, have been awarded a contract by the Union Carbide Co., of Niagara Falls, N.Y.; and Welland, Ont., for three De Laval single stage, double suction, pumps, of 3-million, 2-million and 1-million gals. daily capacity respectively, to be motor driven.,

Aylmer, Ont.—At a meeting of the Town Council on April 2, a bylaw to borrow $29,000 for Hydro power by the issue of debentures was passed, $22,000 being the amount to be set apart for the remodelling of the electrical distribution system and $7,000 for the installation of an electrically-driven pump, a gasoline pump or an electrically-driven fire pump. A by-law will be submitted to the ratepayers on April 30.

The Turbine Equipment Co., Toronto, have been awarded a contract by The Imperial Oil Co., Church St., Toronto, to supply for their new plant at Dartmouth, N.S., 13-De Laval single stage, double suction pumps, ranging in size from 1500 gals. to 350 gals. a minute. The Imperial Oil Co., have also placed another order for two additional single stage, double suction, high lift De Laval pumps, each to be direct connected to 150 h.p. motors.

Lieut.-Col. Wood Leonard, D.S.O., of London, Ont., was killed in action recently in France, while in command of the 3rd Artillery Brigade. Col. Leonard was a son of Frank E. Leonard, and was associated with his father and brothers in the firm of Leonard & Sons, the well known engineers of London, Ont. He was a graduate of the Royal Military College, Kingston, Ont., and went overseas in 1914 in command of the 6th Field Battery. Col. Leonard was 34 years of age.

The Turbine Equipment Co., Toronto, have received a contract amounting to $19,000 to supply and install, 8-De Laval single stage, double suction centrifugal pumps, for the new filtration plant for the town of St. Hyacinthe. One will be 5 million Imperial gals. daily unit, another 4½ million gals. daily, and there will be 6 having capacity of 2½ million Imperial gals. daily. All these pumps will be connected direct to Canadian Westinghouse motors. They will also supply 40 h.p. motor driven Roots blower, complete switch-board etc.

The Turbine Equipment Co., Toronto, has been awarded a contract by the town of Strathroy, Ont., for one multi-stage De Laval centrifugal pump, which will be direct connected to a Canadian Westinghouse 125 h.p. motor; the capacity will be 1,000 Imperial gallons a minute, against 252 ft. total head. They have also been awarded through the Hydro-Electric Power Commission of Ontario one De Laval single stage, centrifugal pump, which will have a capacity of 5,000,000 Imperial gallons a day against 210 ft. total head. This pump is for the City of Kingston, Ont., and will be direct connected to a 380 k.v.a. Canadian General Electric 1,200 r.p.m. synchronous motor.

CATALOGUES

Sight Feed Lubricators.—Two bulletins have been issued by the Penberthy Injector Co., Windsor, Ont., describing and illustrating the "Peerless" and new "Polar" sight feed steam lubricators.

Ball Bearings.—The Rochester Ball Bearing Co., Inc., Rochester, N.Y., have issued Bulletin No. 10, which is a descriptive price list covering the "Rochester" ball thrust bearings. The bulletin contains a description of the bearings and tables giving the principal dimensions and prices.

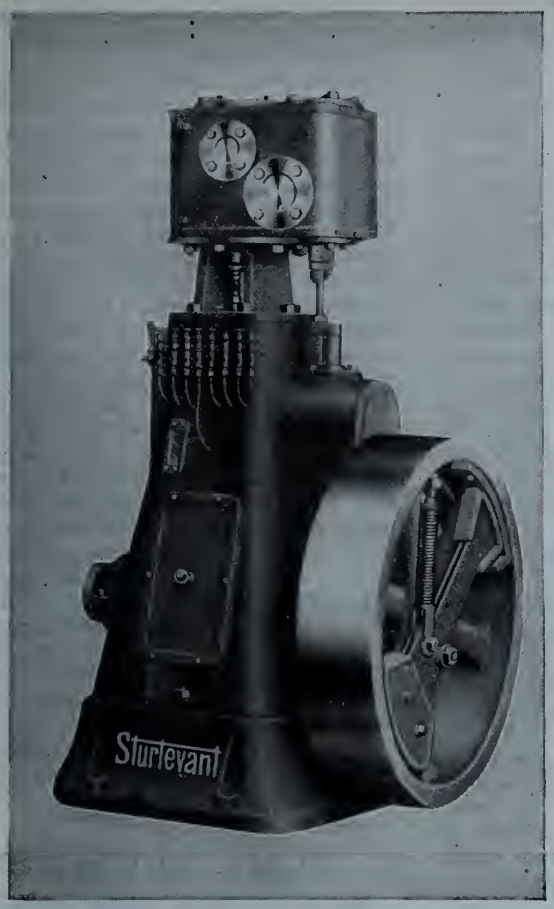
Circulating Pumps.—A bulletin dealing with a line of circulating pumps for machine tools, has been issued by C. F. Roper & Co., Hopedale, Mass. The principal features of construction and method of operation on the Roper geared pump are described fully, accompanied by illustrations which include dimensioned diagrams for various sizes.

The Homestead Valve Mfg. Co., Homestead, Pa., are distributing a bulletin bearing the title "Safety First, then Efficiency, then Economy," having reference to the Homestead line of valves. The "Hovalco" blow-off valves and "Homestead" quarter-turn valves are also illustrated and described.

Hydraulic Presses.—An interesting and varied line of hydraulic presses is described and illustrated in a series of leaflets distributed by the Charles F. Elmes Engineering Works, Chicago, Ill. The principal dimensions are given for the various sizes of each type, and also of equipment used in their operation such as hydraulic pumps, valves, etc.

Automatic Plate Valves.—The Mesta Machinery Co., Pittsburgh, Pa., are distributing a new bulletin dealing with the Mesta automatic plate valves (Iversen Patent). The principal features and general construction of the Mesta valve are described in detail accompanied by illustrations. The suitability of this valve for use in air and gas compressors and blowing engines is mentioned in this bulletin.

Taylor Power Dump.—Catalogue issued by the American Engineering Co., Philadelphia, Pa., describing the Taylor power dump for use in conjunction with the Taylor mechanical stoker. The construction of this power dump and re-



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(Trade Mark)

Vertical Engines

Admirably adapted to isolated installations because entirely enclosed, automatically lubricated, and requiring very little attention.

Compact—quiet in operation—and dependable in the highest degree.

Built in a wide range of sizes and with either forced feed lubrication or automatic gravity lubrication through sight feed glasses.

Described in Bulletin 218-E.

B. F. Sturtevant Company of Canada, Limited
GALT, ONTARIO, CANADA
MONTREAL TORONTO WINNIPEG VANCOUVER

Selling Agents for Sanford Riley Stoker Co., Limited,
THE RILEY STOKER

AGENTS WANTED FOR CANADA

FOR

High Efficiency Centrifugal and Turbine Pumps

Design and Material of Highest Class

PRICES MODERATE

LARGE NUMBERS OF

Special Designs for Special Requirements

PULSOMETER ENGINEERING CO., LTD.

11 Tothill Street, LONDON and Nine Elms Iron Works, READING

If any advertisement interests you, tea identify the proposition about which you require information.

WALTER J. FRANCIS, C.E. M. Can. Soc. C.E. M. Am. Soc. C.E. M. Inst. C.E.
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Head Office, 232 St. James St., Montreal
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We carry a large stock of Steel Plates, Channels, Beams and Angles.

PROMPT DELIVERIES.

MacKinnon, Holmes & Co., Limited
Sherbrooke, Que., Canada

BOILER SCALE Never Was NEUTRAL

It is always on the offensive, coating the shells and tubes of the boiler and greatly lowering the boiler steaming efficiency.

DIXON'S PIONEER BOILER GRAPHITE

is flake graphite. Flake Graphite is the "sapper" that undermines and penetrates the scale at the time of its formation.

Dixon's Pioneer Boiler Graphite attacks scale on all sides, rendering it easy to remove when a cleaning tool is used in the ordinary way.

One engineer effected a saving in cleaning cost of 28¾c on each boiler tube by using "Dixon's Pioneer" method.

Why don't you?

Send for booklet 222T.

Made in JERSEY CITY, N.J., by the
Joseph Dixon Crucible Company
Established 1827
Sole Canadian Agents
Canadian Asbestos Co.,
Montreal, Que.

sults accomplished by it are described while the method of operation is graphically explained by means of a number of illustrations.

The American Pulley Co., Philadelphia, Pa., have issued a booklet entitled "Building 25," descriptive of a new building recently opened at the plant for the convenience of workmen and for safeguarding their health. The booklet contains descriptive matter, and also a series of photographic views showing the principal features of the building, embodying the latest ideas applied to the preservation of health in factories.

A. C. Generators.—T. W. Broadbent, Ltd., Huddersfield, England, have issued a new bulletin, No. 4, dealing with their T. Type three-phase generators, designed especially for motor driving. A full description is given of this machine, accompanied by illustrations, while a price list is included, giving capacity and weights for each size of generator and exciter. Copies of the bulletin may be obtained on application.

Water Heaters.—The Alberger multi-head water heater for hotels, office buildings and factories, is described in a Bulletin No. 201 recently issued by the Alberger Heater Co., Buffalo, N.Y. The principal constructional features of the multi-head heater and their advantages are described fully, special reference being made to the method used in the heater to accommodate unequal expansions. The bulletin is illustrated.

Row & Davis, Engineers, Inc., 90 West street, New York, have just published two interesting bulletins, copies of which will be mailed to readers on request. "The R. & D. Paracoil "Evaporator," Bulletin No. 51, for single or multiple effect operation. The bulletin shows and describes the evaporator thoroughly. The most interesting feature, perhaps, is the patented new type of manifold, which is mounted on a hinged door to facilitate inspection, cleaning, etc. Bulletin No. 52, "The R. & D. Feed Water Heater" fully describes the shell, manifolds, coils, connections and fittings of their heater. These bulletins should be in the hands of every engineer interested in feed water heating and water distillation.

Dynamos and Motors.—Pamphlet No. 21-C, recently issued by Bruce Peebles & Co., Ltd., Edinburgh, Scotland, illustrates and describes the "Peebles" self-contained continuous current dynamos and motors. A full specification is included covering these machines which are made in various types such as protected type, semi-enclosed, totally enclosed, mining or pipe ventilated type. The first half is taken up with the specification, while in the latter half very complete lists of output ratings are given for the usual standard voltages, and for every size of machine which they manufacture, separate output ratings being given for each of the five different types enumerated above. To assist intending purchasers in laying out their plant, there are also given two pages of approximate weights and dimensions, while on the last page there is an illustration of two machines mounted together, and arranged as an ordinary motor generator, booster or three-wire balancer. Copies of this pamphlet will be gladly sent to anyone interested.

Ball Bearings for Transmission. — The Chapman Double Ball Bearing Co., of Canada, Ltd., Toronto, have issued to the trade a new 48-page bulletin No. 107. This bulletin, which is a very attractive publication, illustrates and describes fully, a standard line of power transmission bearings. Among the illustrations are included a number of sectional views of bearings showing the principal features embodied in their design. The section of the bulletin devoted to the development of the Chapman double ball bearing contains much useful information covering the design and scientific features of this bearing, while details of tests are also included with views of the apparatus used for the tests. The application of ball bearings for loose pulleys and pillow blocks is also dealt with, fully accompanied by dimension tubes and price lists. One interesting feature comprises a number of excellent full page half-tones, showing a variety of power transmission installations equipped with the Chapman product, and also interior views of the company's plant.

BOOK REVIEWS

Mechanical World Pocket Diary and Year Book for 1917, 453 pages, 6 in. x 4 in. Norman Remington & Co., Baltimore, Md. Price 40 cents post free. The 30th annual issue of this year book, published by Emmot & Co., Manchester, contains several new features, while the book generally has been thoroughly revised. The section on steam and the steam engine has been rewritten. New tables have been introduced, giving dimensions of piston rings, governors, etc., while notes on lubrication and anti-friction bearings are now included. A new section on the heat treatment of steel has been introduced, including notes on annealing, hardening, tempering, etc. Other new matter includes tables, giving dimensions of flanged couplings and calculation of springs. Much recent information is also given regarding design of prime movers, boilers, power transmission, machine shop practice and materials. A 57-page diary and memoranda is a useful feature of this publication.

Water Powers of Manitoba, Saskatchewan and Alberta, a well-bound and attractively illustrated volume, just issued by the Commission of Conservation, forms a valuable contribution to the authentic literature respecting the natural resources of Western Canada. This report, by Leo G. Denis and J. B. Challies, comprises the results of special surveys by the Commission of Conservation and a compilation of records from other reliable sources. As a compendium of all available data on the subject, it is particularly valuable

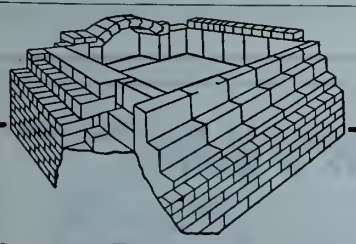
for reference purposes. While the Prairie Provinces, as a whole, are not lavishly endowed with water powers, the report demonstrates that the utility of their rivers for power development can be vastly enhanced through proper storage of flood waters. At present, in the absence of conservation dams, and of adequate natural regulation, the great volume of flow is lost during high water seasons. Methods of development to ensure the maximum utilization are now being carefully worked out on the Winnipeg, Bow and other large rivers. The more northerly regions possess numerous sites of great potential value for pulp, electro-chemical and other special industries. The report just issued is the second in the series on water powers in Canada to be published by the Commission of Conservation. The third volume, "Water Powers of British Columbia," which is now in press, will complete the Commission's general inventory of this item of the Dominion's natural wealth.

"Combustion in the Fuel Bed of Hand-fired Furnaces," is the title of Technical Paper 137, by Henry Kreisinger and others, which has just been issued by the Bureau of Mines of the Department of the Interior, Washington, D.C. The main object of the investigation was to determine the conditions governing the process of combustion in the fuel bed of a hand fired furnace. The results of this investigation furnish data for correct design of coal-burning grates and furnaces and their efficient operation. They also cast light on the important problem of clinker trouble as related to fusibility of ash. They further indicate the possibility of a high rate of gasification of coal in gas producers. The first part contains general information on the combustion of coal in furnaces. The second part contains the description and the results of about fifty tests made in a small experimental hand-fired furnace, which was designed for an accurate study of the processes of combustion in the fuel bed. The third part discusses the investigations described in the second part of the report, and includes about forty charts that show the composition of the gases and the temperature at different depths in the fuel-bed of a hand-fired furnace, and various relations between the air supply and the rate of combustion. The fourth part contains miscellaneous data on the composition of gases rising from the fuel bed of a hand-fired furnace under a steam boiler, a Murphy stoker, and a Jones underfeed stoker. Copies of this technical paper may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D.C.

CLASSIFIED ADVERTISING

WANTED—A GOOD SALES ENGINEER to open office to sell Moline heat in Canadian territory. Must be a good salesman, having had a general heating and ventilating experience. Must give good references. We have a fine proposition for the right man. Address Moline Heat, Moline, Ill. ctfm

3 TRANSFORMERS, ALL NEWLY PAINTed and equally as good as new. Type D-T Crocker-Wheeler, K.V.A. 75, phases 1, cycles 60, primary voltage 2,200, secondary voltage 550, primary amps. 34.1, secondary amps. 136.4, numbers 2849, 2850, 2851. Apply Howard Smith Paper Mills, Ltd., Beauharnois, Que. P4H



Gates Boiler Furnace
Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

—WRITE FOR PARTICULARS—

John W. Gates, 382 St. James St., Montreal, Que.

U.S. METAL POLISH

Works Equally Well on Hot and Cold Surfaces. It Cannot Blow Up. Cleans, Polishes and Preserves all kinds of metals.

Tear this off as a reminder

Geo. Wm. Hoffman Co., 557 E. Wash. St. Indianapolis, Ind.

Enclosed find 10c in stamps, for which send me one large 50c can of U. S. Metal Polish Paste.

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Cameron Babbitt Retainer

(Patented in Canada and the U.S.A.)

Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box. For any metal.

The only satisfactory compound for retaining molten metal and can be used over and over again for months—no deterioration.

For prices and samples apply to

A.S.K. Chemical Company, Elora, Ontario

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

Trap Every Steam Line with a SARCO

High Cost of Steam

versus

Low Cost of Trapping

There was a time when steam was cheap. Not now. Now it costs more than at any time within a hundred years.

There was a time when all steam traps were expensive, big, cumbersome, troublesome things.

Not now. Now you can use the Steam Trap SARCO, which is small, low-priced, absolutely efficient and reliable, and goes right on any line anywhere.

Many untrapped lines steal the cost of a Sarco every week.

The Steam Trap SARCO relies on the expansion of a heavy hydrocarbon oil operating a Sarco Spiral Tube with a renewable cartridge. When steam reaches the cartridge, the trap closes and no steam escapes. When condensation collects the trap opens and discharges it.

Write for Bulletin J—2.

SARCO COMPANY INC.
Woolworth Building New York,
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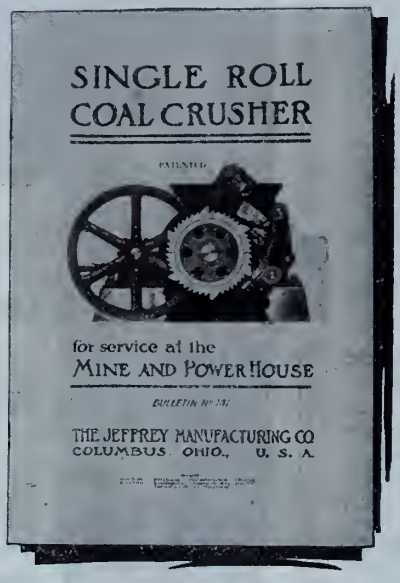
Monadnock Block, Chicago.
Canada: Peacock Brothers, Montreal

How to Secure a Constant Supply of Right Sized Stoker Coal at a Minimum of Cost? ↓



You will find the answer by reading this book — describing in detail the Design and Construction of the

Jeffrey Single Roll Crusher

the machine which will crush more coal with less power and expense than any other on the market.

A single operation will reduce run-of-mine coal to ¾ or 1 in. (the proven size for maximum stoker efficiency) **in a single operation.**

This book also contains many splendid testimonials from many users, as well as drawings and suggestions as to the ways in which the crusher can be installed in connection with various types of elevating and conveying machinery.

If your power plant is not equipped with the Jeffrey Single Roll Crusher, you are overlooking the most important element in your fuel expense. Fill out the coupon and get a free copy of this interesting book.

RETURN COUPON

The Jeffrey Mfg. Co., Power Bldg., Montreal

Please send copy of Bulletin No. 141.

Name .....

Address .....

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Power House

Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

Regulating Valve Placed at Any Point, Any Position.

The "S-C" Regulator Company

Feed Water Regulation Engineers

FOSTORIA, OHIO, U.S.A.

It may never happen to you—but are you SURE it WON'T?

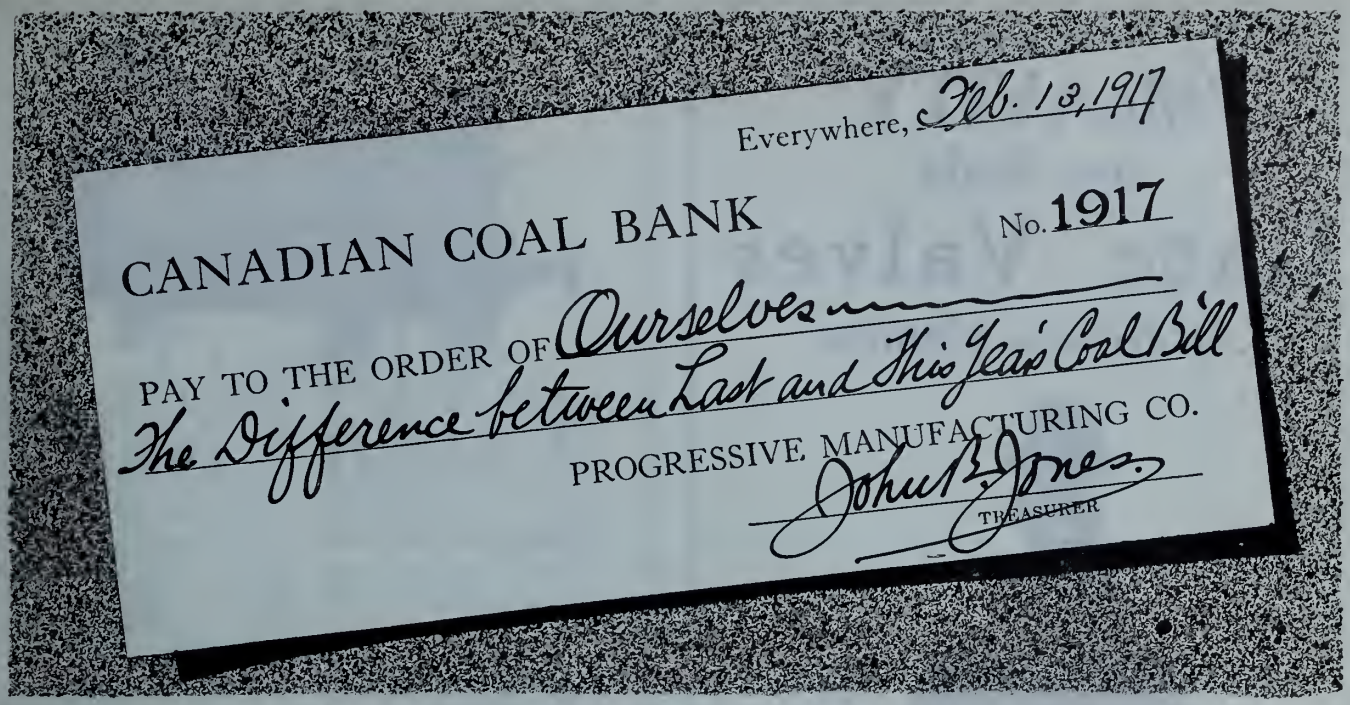
Accidents due to high and low water are occurring continually. Your plant may never suffer, but have you assurance that it won't? Have you taken the necessary precautions against this danger?

The Vigilant Feed Water Regulator is guaranteed to keep water level within ¼" of middle gauge. It is a positive prevention of dangers arising from high or low water.

Investigate it to-day!

The Chaplin-Fulton Manufacturing Company

28 Penn Avenue - - Pittsburgh, Pa.



Why Don't You Pay the Increase in Your Coal Bill to Yourself?

Last year, a certain plant, operating 5 boilers to capacity, paid $3.20 per ton for coal. Consumption averaged 15 tons per day.

Then their coal contract expired, the shortage came on and the price jumped to $4.20 per ton—just 31%. This meant an annual increase of $5475 in their coal bill! Naturally, this was a serious matter and the management, as well as the engineer, set themselves to work to reduce the heavy increase in cost.

Realizing that scale is one of the most prolific sources of fuel waste in the boiler room, the engineer suggested that a Dean Boiler Tube Cleaner be procured and the tubes thoroughly cleaned. The order was placed at once and the Dean installed.

Dean

Reg. U. S. Pat. Off.

Nearly 4000 lbs. of scale were removed from the five boilers! When cleaning was completed it was found that all the power required could be easily developed with four boilers (instead of the five previously required)!

The cutting out of one boiler reduced coal consumption 20%—lowering the increase in cost to 5%. Further experiments in flue gas analysis and a more careful system of firing resulted in a 10% additional saving.

To-day, this plant, despite an increase in coal cost of 31%, is paying 6% less for coal than it did last year!

Let the Dean show you how to do it

If your coal costs are going up, the Dean Cleaner will help you reduce them. The Dean cleans boiler tubes more thoroughly than any other method or device.. Consequently, Dean-cleaned boilers steam better and consume less fuel.

The Dean is ready to show you how it will cut your coal costs. You may try it without expense or obligation to purchase. Just tell us the size of your tubes, type of boilers, and where to ship. If the Dean doesn't make good, ship it back and we lose.

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Iron Body
Gate Valves
All Bronze Fittings

Made in Sizes from 4" to 24".

Screwed, Flanged or Hub End

with Inside Screw or Outside Screw and Yoke. Fitted for Hand Wheel or Wrench. Either with Bronze Seats or Hard, White Metal Renewable Seats.

Write for copy No. 1004 catalogue.

T. McAVITY & SONS
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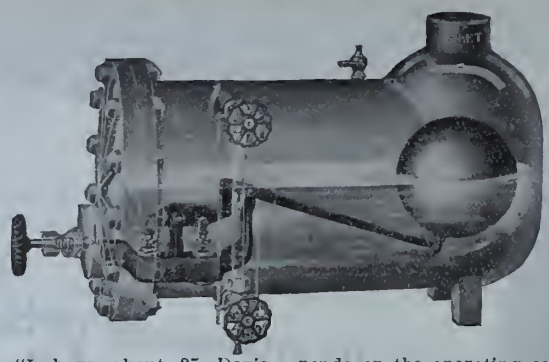

"I have about 25 Davis Traps of various sizes in service, the majority of them for 22 years. I will gladly recommend them at all times," wrote H. F. Hustedt, Chief Engineer, Tulane University, New Orleans, when ordering his first repairs.

Possibly all Davis Traps would not last that long without repairs. Much depends on the operating conditions. On some installations they last longer than on others. But all Davis Traps have Tobin Bronze seats and valves—a hard, tough metal from which long service may be expected.

And when these vital parts of the trap do wear out, they may be easily renewed at slight expense.

We make Pressure Regulators . Balanced Valve . Float Valve . Steam Trap . Back Pressure Valve . Exhaust Relief Valves . Stop and Check Valves . Pump Governors . Damper Regulators . Radiator Air Valves . Emergency Stop Valves.

G. M. Davis Regulator Co.
434 Milwaukee Avenue, Chicago., Ill.

New York, 123 Liberty—Boston, 70 High—Philadelphia, 260 N. 11th—The Renshaw Bldg., in Pittsburgh—Calvert in Baltimore, and Rialto in San Francisco.

Valve Specialty Manufacturers Since 1875

You are Paying Too Much for Coal

THE COE Turbine Undergrate Draft Blower will cut your coal bills, because it will enable you to burn the CHEAPEST grades of fuel, efficiently, economically and well.

The COE Turbine Blower

is cheaper and better than a Central Plant; cheaper because it costs less to install and keep up, better because each boiler is equipped with its individual blower.

The COE Blower will greatly increase your boiler capacity, produce complete combustion, and eliminate smoke. And because your draft is mechanically made you are independent of the changes in the wind or weather.

AUTOMATICALLY CONTROLLED. Once regulated it is set for good. Responds quickly to demands. No peak too great to meet. Will not harm the boiler. Endorsed by prominent engineers, and used by many large power plants. Easily installed.

YOU NEED IT. Write for prices and our special proposition.

C. T. COE COMPANY
10-14 Johnson Street **NEWARK, N.J., U.S.A.**

AGENTS FOR DOMINION OF CANADA:
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"Boiler Scale Troubles have ended"

This is the proof of the efficiency of

"Imperial" Boiler Coating

that is reaching us by every mail. Imperial Boiler Coating has never failed to remove scale where it has been given fair trial — and because of this we are willing to send you a sufficient quantity to satisfactorily treat your boiler against scale formation on the fair basis of **"satisfaction or no pay."**

Imperial Boiler Coating is not a compound and there are positively no acids, graphite or other harmful ingredients in it.

Try it and you'll want more.

Drop us a line to-day for prices, etc.

Crown Manufacturing Co.
CLEVELAND
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POSITIVELY NO LEAKS

The Joint is BRONZE against BRONZE—which means no deterioration.

IRON PARTS ARE HEAVY—they will not stretch or pull apart.

DART Union Pipe Coupling

DART UNION PIPE COUPLINGS ARE EASY TO USE—an inexperienced hand can quickly make a permanently tight connection whether pipes are in or out of alignment. They require no attention when in service and never have to be replaced.

Dart Unions have no cored parts or recesses to hold moisture and sediment or obstruction to retard the flow.

Made in a variety of styles to fill all requirements. Positively guaranteed.

SOLD BY ALL FIRST-CLASS SUPPLY HOUSES

Made in Canada by

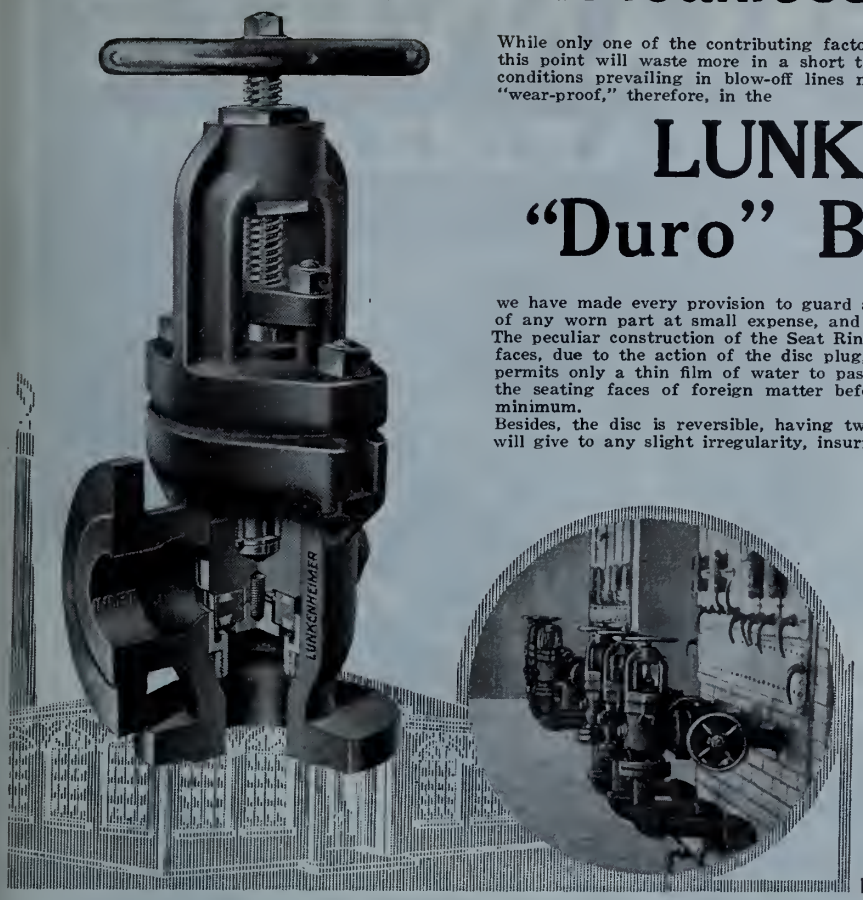
DART UNION COMPANY, LIMITED

TORONTO, CANADA

DART

Trade-Mark

A leakless blow-off---



While only one of the contributing factors in boiler economy, is of vital importance—a small leak at this point will waste more in a short time than the cost of a good valve. The extremely severe conditions prevailing in blow-off lines make it impossible to construct a valve that is absolutely "wear-proof," therefore, in the

LUNKENHEIMER "Duro" Blow-off Valve

we have made every provision to guard against and reduce wear, and to permit the repair or renewal of any worn part at small expense, and without loss of time.

The peculiar construction of the Seat Ring and Disc in the "Duro" provides self-cleansing seating surfaces, due to the action of the disc plug, which cuts off the inlet when the valve is being closed and permits only a thin film of water to pass between it and the cylinder of the seat to thoroughly cleanse the seating faces of foreign matter before the disc is brought home, thereby reducing wear to a minimum.

Besides, the disc is reversible, having two alloy faces which, being softer than the seat ring material, will give to any slight irregularity, insuring a tight valve at all times.

Stem and bearings are bronze, and all parts, including the reversible disc and the seat ring, can easily be renewed.

The materials used and the workmanship are of that high order which characterizes all Lunkenheimer Products.

Specify Lunkenheimer "Duro" and insist on getting the genuine.

Your local dealer can furnish them; if not, write us.

Write for Booklet No. 515-DC.

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High-Grade Engineering Specialties in the World

Cincinnati, O., U.S.A.

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16-12-43

KERR

("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

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PACKING STANDARDIZATION

Sifting a thousand packings to give you the best

IF EVERY screw-thread had a different pitch, and for each thread you bought nuts of varying styles, because each was strongly recommended—repair jobs would last a lifetime, and emergency stocks would reach huge proportions.

Yet this is virtually the packing situation — or was, until Johns-Manville undertook Packing Standardization. Fifty-seven brands for each stuffing-box—annual fashions; heavy expense incidental to the manufacturer of varieties, and most of this expense passed on to consumers; economic waste, fighting brands, and, as a whole, inadequate solutions of packing problems.

So we decided to standardize our packings, and were prepared for initial loss of business. But as a matter of fact our business jumped. Engineers found that instead of repacking three times a season, a set of Sea Rings lasted two or three years—and they found new places all around the plant for this long-serving power-saver. So with Universal, with Service Sheet—with all the J-M Line.

By designing, not for selling novelty but for service, we've simplified your buying—and in so doing have improved each individual packing and advanced packing science. We've taken packings out of the bulk material class and put them on a straight engineering basis.

Fewer packings, and *better* packings—that's the achievement of Johns-Manville Packing Standardization.

THE CANADIAN H. W. JOHNS-MANVILLE CO., Limited

WINNIPEG TORONTO
MONTREAL VANCOUVER

JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

Detroit Lubricators

Have Given Satisfaction For Forty Years.

Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

ALBANY GREASE

PERFECT LUBRICATION

for every bearing in your plant may be secured with Albany Grease. Perfect not only in keeping the bearings running cool and easy, but in the elimination of friction and the reduction of wear and tear to the minimum.

ALBANY GREASE

should be used on every bearing in your plant—always. Albany Grease contains nothing harmful to bearing surfaces and can be used in any kind of grease cup. Send for a trial quantity and a cup—now.

ALBANY LUBRICATING CO.
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COAL FAMINE

You owe it to the Empire that you get the utmost out of your Steam Plant. Your competitors have found that the use of our Boiler Preservatives, Protecto and Protectocoat, for interior and exterior use on your Boilers, are essential to get same along with *Plibrico One-Piece Lining* and *Plibrico High Temperature Bond for repairs*. These materials are revolutionizing Boiler Room Costs.

PROTECTO
BOILER PRESERVATIVE

Is not a water treatment but has an affinity for hot metal. After clearing your Boiler Plates and Tubes of Scale it forms a protective enamel to which further scale will not adhere. We are willing to give you thirty days' free trial and ABSOLUTELY GUARANTEE PURE STEAM. Prevents foaming or priming.

PROTECTOCOAT
FOR COATING YOUR BOILER BRICKWORK

Fills up present cracks and prevents new ones forming. Will last FOUR YEARS. Cold air penetrates all untreated brickwork and thereby reduces percentage of Carbon Dioxide in your chimney gases from the practical Maximum percentage of 14% to perhaps as low as 3%, entailing a loss per $1000 fuel of $15.00 to $535.

Do you know that 1/16th inch Scale on inside of Boiler Shell will waste 13% of Fuel?

ELECTRIC PLANTS. We represent a maker of everything in Vulcanized Fibre products.

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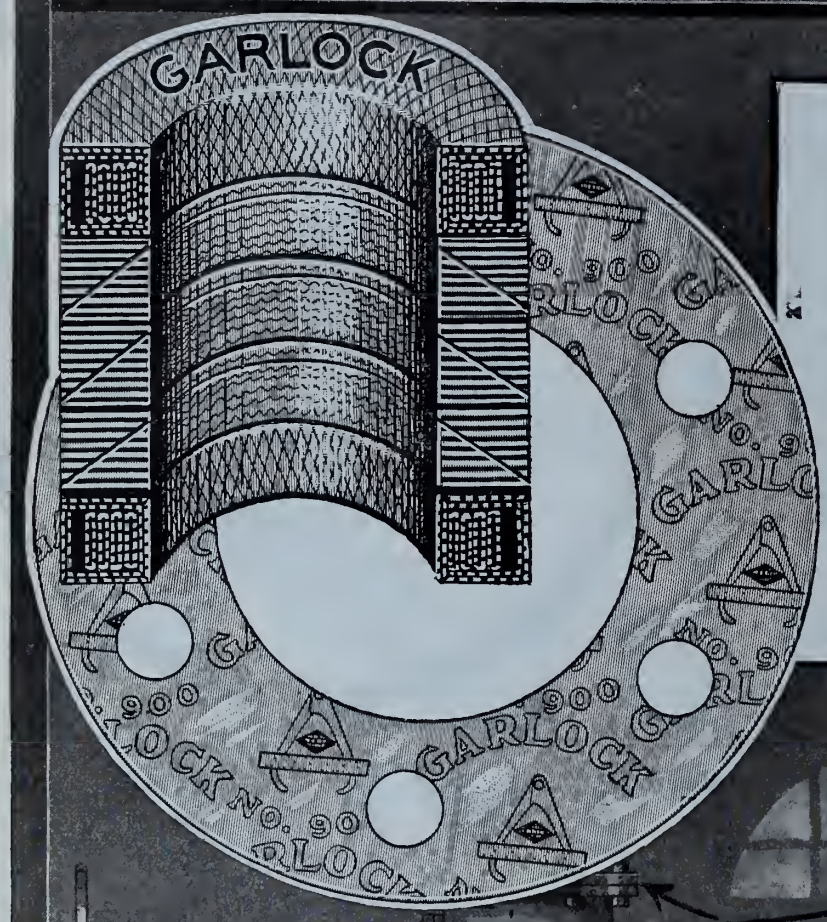
If any advertisement interests you, tear it out now and place with letters to be answered.

GARLOCK PACKINGS



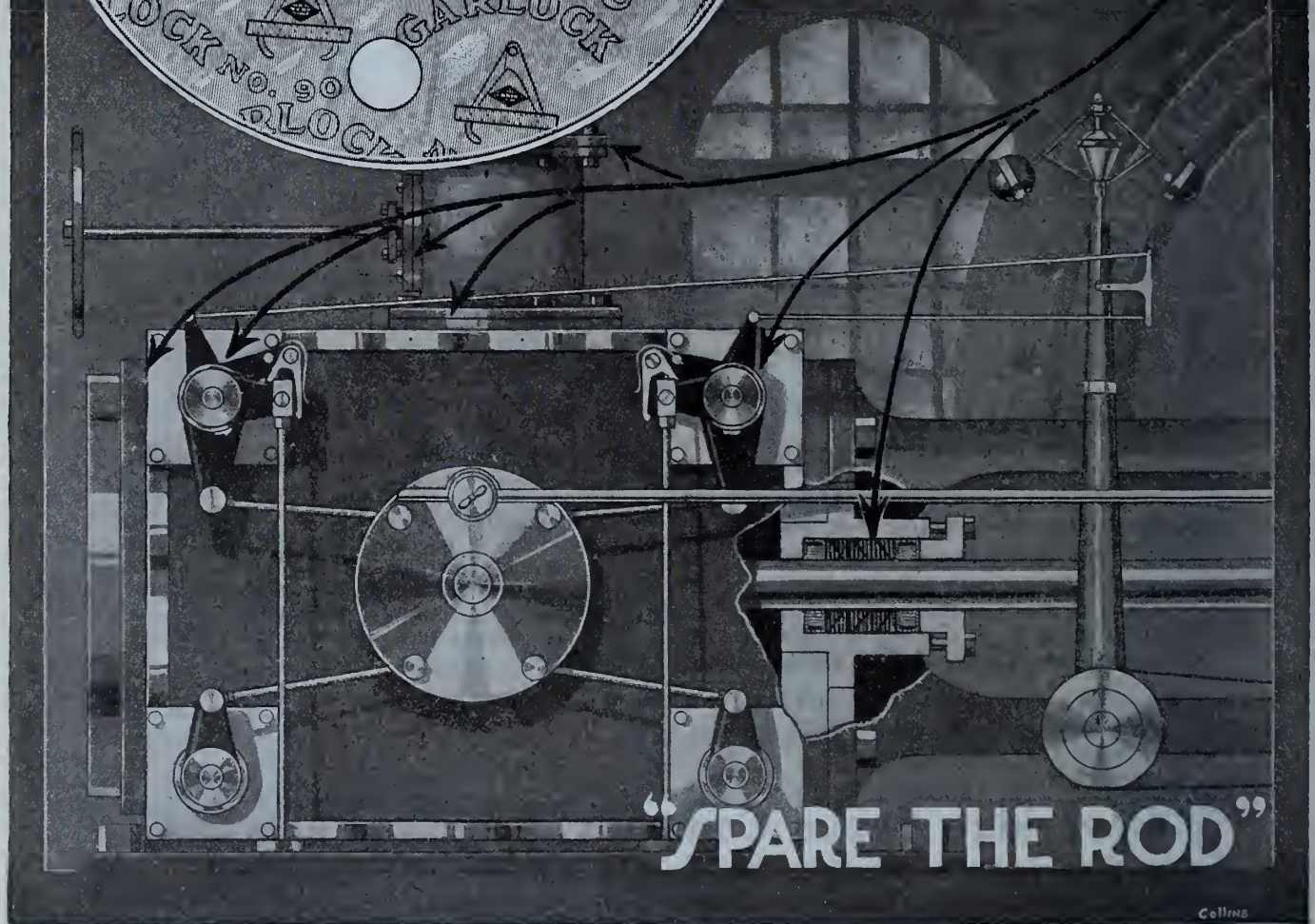
Pointers on a Well Packed Engine

For high pressure piston rods and valve stems, use Garlock No. 200.

For medium pressure piston rods and valve stems, use Garlock No. 446.

For cylinder head, flange and other joints, use gaskets cut from Garlock No. 900 Sheet (No. 950)

The Garlock Packing Co.
Hamilton, Ontario
Branches in Principal Cities



"SPARE THE ROD"

COLLINS

Your Belting Upkeep

Have You Cut It To The Irreducible Minimum?

Discipline of war has served to increase economy and create greater efficiency. Assuming you've used the pruning knife in your plant, how did you find your belting *upkeep?* Heavier than it ought to be? Are your belts requiring too much attention through slippage, breaks and other defects, unreliable makes. No need for this loss.

D. K. McLaren's Leather Belting

WILL INSURE YOUR PLANT AGAINST
BELTING INEFFICIENCY

Genuine British Oak Tanned

This most thorough process of Tanning our belts preserves every bit of the hide's original strength and makes it proof against stretching and all other weaknesses, liable to show up under severe strain. McLaren's products will do all that is expected of belts.

TRADE MARK

D·K·McLAREN LIMITED

HEAD OFFICE AND FACTORY:
351 ST. JAMES STREET, - MONTREAL, P. Q., CANADA

TORONTO, ONT.
194 King Street West

ST. JOHN, N. B.
64 Prince William Street

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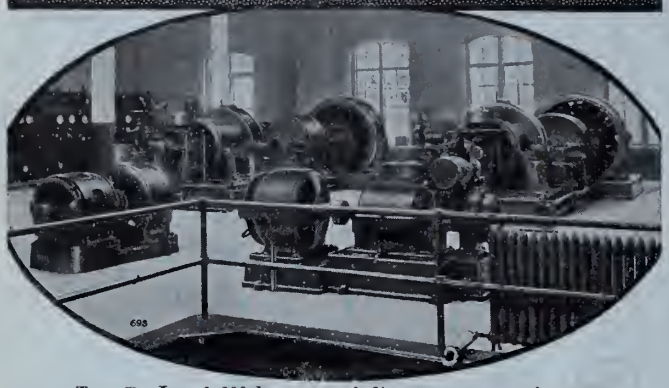
847 Beatty Street

If any advertisement interests you, tear it out now and place with letters to be answered.

DE LAVAL
Geared Direct Current Turbo Generators



Two De Laval 600-kw. geared direct-current turbo generators installed for the Pacific Mills, Lawrence, Mass., high pressure condensing service, supplying power to variable speed print machines.

Flexible, Accurate Speed Control and Maximum Output Made Possible by De Laval Geared Direct-Current Turbo Generators

When alternating current distribution, speed variation for individual machines is difficult. With direct-current, on the other hand, each machine can be studied separately and speeded up to the maximum, thereby increasing the output.

The gain thus obtained over fixed speed throughout may amount to 5 or 15%.

A direct-current generator geared to a steam turbine is superior to transformers and rotary converters, as it is more efficient, costs less, occupies less space and involves less complication.

The installation shown has given reliable and efficient service since it was put in service over three years ago.

The use of the gear permits the steam turbine to run at the best speed for efficiency and simplicity. The turbine can be adapted to any steam conditions, as high pressure condensing, exhausting against back pressure, exhausting partly to condenser and partly to manufacturing processes, or utilizing the exhaust of reciprocating units.

All De Laval Machines are distinguished by moderate peripheral speeds, large running clearances, horizontally split casings, close speed control, interchangeability of parts, due to manufacture on the limit-gage basis, and the fact that each machine is guaranteed as to efficiency and is fully tested at the builders' works.

Ask for Catalog No. 48 and state conditions of use so that detailed information can be sent.

DE LAVAL

Reg. U. S. Pat. Office.

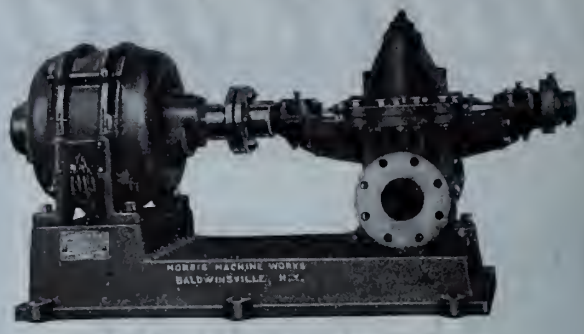
STEAM TURBINE COMPANY

Trenton, New Jersey

TURBINE EQUIPMENT CO., LIMITED,
Canadian Pacific Bldg., TORONTO, Canada.
THE E. LAURIE CO., 243 Bleury Street,
MONTREAL, Que.

231

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2″ to 20″ discharge.

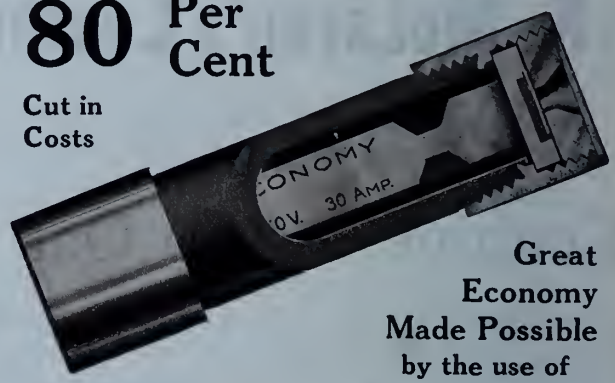
Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.

Builders of Centrifugal Pumps, Hydraulic Dredges, Steam Engines

Canadian Sales Agents:
Storey Pump & Equipment Co., Toronto, Can.

80 Per Cent
Cut in Costs



Great Economy Made Possible by the use of

ECONOMY
Renewable Cartridge Fuses

With the aid of our inexpensive "Drop Out" Link of fusible metal you can renew a blown Economy Renewable Cartridge Fuse, and have it back in the circuit doing faithful and efficient duty in a moment.

The man who buys the fuses can save his firm a mint of money in a year's time—a cut of 80% in costs is made in thousands of plants of all kinds.

No experiment—millions in use. Sanctioned by Canadian Fire Underwriters' Association. Samples supplied. Send for Catalog 24.

ECONOMY FUSE & MFG. CO. OF CANADA, LIMITED

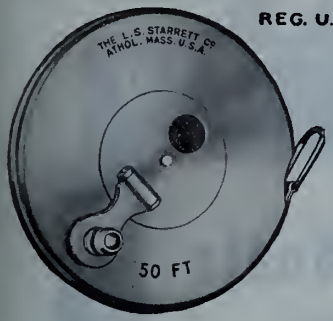
UNITY BUILDING - MONTREAL

Manufacturers in Canada of "S. & C." High Potential Fuses,—to 150,000 Volts.

TRADE MARK

Starrett

REG. U.S. PAT. OFF.



Quick Reading Steel Tapes

For taking belting lengths or whatever long measurements are required, you want tapes that can be relied on for accuracy and which are convenient to use. Starrett tapes are graduated accurately and you can't misread the figures, because of the special black finished background, bright figures, and clear graduations. The foot figures before each inch mark permit quick, safe reading. These tapes are made in various sizes and styles. Every engineer should have a Starrett Tape in his kit.

Write for free catalog No. 21CD, describing these tapes, speed indicators, ratchet wrenches and hack saws.

The L. S. Starrett Co.

The World's Greatest Toolmakers.

Athol. Mass.

42—640

BOWSER

ESTABLISHED 1885

Lubricating Oil Filtering and Circulating System

5F TYPE

THE Bowser System of batch filtration of lubricating oil is recognized by all engineers as being the most efficient for turbine use. Systems such as the one illustrated are built for any capacity; the precipitation and filtering area are features that appeal to every engineer.

Filter sections are easily accessible and removable for cleaning, and can be cleaned after removal, with utmost ease.

Write us for detailed information to-day.

S. F. BOWSER CO., Inc.

Fort Wayne, Ind.

Sales Offices in all Centres *Representatives Everywhere*

WHEN a certain manufacturer bought his belts, the salesman told him to "run them at just the right tension."

So once a month every belt was tested, and if not tight enough it was taken up, this work being done on Sundays and holidays, at "time-and-a-half."

But this made his friction load high. Bearings required too much oil, and when his belts slipped, men and machines had to stand idle until they were taken up. So finally they used belt dressings, rosin, soap or "a little castor oil" to stop the slipping, and now his belts give him more constant trouble than anything else in the plant.

* * * * * *

There is another man in his town whose belts are old. He hasn't tried the tension for many years, because there isn't any tension. They run easy or slack, and when called upon for extra duty they respond cheerfully.

For this man has long since learned the CLING-SURFACE way. His belts never slip, even when running heavy, and the friction load is very small. About once a month or oftener, depending upon how long the belt has been treated, one of his men takes a stick with a rag wrapped around one end, and dipping it in the CLING-SURFACE he places it against the face of a belt, passing it across until a very light stain appears on the pulley faces. Then he stops: that belt is trouble-proof.

Simple, isn't it? Yet the greenest workman can apply the new semi-liquid "easy-to-use" CLING-SURFACE safely, economically and correctly.

Instead of tying up the shop with "belt trouble," wearing out men and equipment, and having overtime charges to meet, **ONE MAN**, with a bucket of **CLING-SURFACE**, treats the belts. Oil, coal and time is saved, more power is delivered, and the drives become cheerful workers instead of disagreeable kickers in your factory.

Let us prescribe for YOUR drives; our service is free, **CLING-SURFACE** is guaranteed, and we have a plan 10,000 firms have found successful.

Remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface Co

1057 Niagara Street

Buffalo New York

Sliptivity
SteamCylinder

Sliptivity
Steam Engine

Automobile
Cylinder

OILS

These Lubricants give remarkable service. They will keep your machinery running smoothly, easily and with a minimum of wear and cost.

No better time than now to put them to the test. The prices are very reasonable.

Potato Scale Powder Boiler Cleanser

Will positively rid your boilers of old scale and will *keep* tubes clean if but a small amount is fed daily through the feed water.

Eliminates foaming, pitting or any other boiler troubles due to impurities in the water supply. *Makes big reduction in fuel bills.*

Sold UNDER A POSITIVE GUARANTEE. Try a Barrel.

C. C. SNOWDON

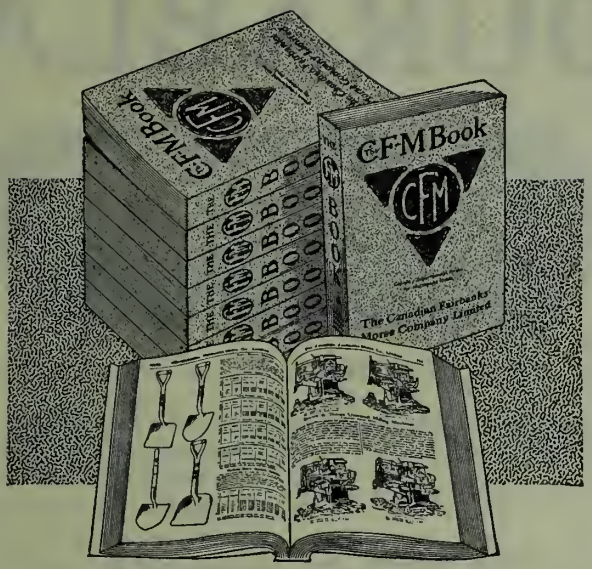
Oils Refiner, Manufacturer and Importer, Pennsylvania, Lubricating and Refined Oils, Gasoline, Potato Scale Powder, Liquid Soap, Disinfectants, Polish, Waste, Oil Tanks, etc.

Winnipeg—Cor. Notre Dame and Pine Sts., P.O. Box 1984.
Vancouver—823 Powell St.
Calgary—1S10-1840 Eleventh St. E., P.O. Box 1384; P.O. Drawer 166.
Edmonton—Cor. 13th Ave. and 83rd St., P.O. Box 877.

Good things for the POWER PLANT

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS



Ready in 30 Days

The most complete book of its kind ever issued. It is an encyclopedia of Mechanical Goods. When in need of Machinery Supplies, get the habit.

The C-F-M Book

(See the F-M Book)

You will find in this book a very complete line of the most up-to-date equipment and supplies, including

Scales
Valves
Steam Goods
Automobile Supplies
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THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

SPECIFY DURABLA PACKING

DURABLA
TRADE MARK

DURABLA
TRADE MARK

Note the Durabla Trade-Mark all over the sheet. A Guarantee of Quality.

Durabla is a Long Fibred Asbestos Sheet sold on Service Basis and guaranteed to make a Tight Joint.

It is the Bond that is the most important part of an Asbestos Sheet.

Only when you combine the right Binding materials with High Grade Long Fibred Asbestos do you secure a perfect Asbestos Sheet Packing.

Therein lies the Secret of the wearing Quality of Durabla, the Packing that will keep any joint tight, and stand everything that the Flanges will stand.

Durabla does not crack or dry out. It can be rolled and unrolled and will not deteriorate in stock.

On saturated and superheated steam, High and Low Pressures, Air, Gas, Oil and Ammonia, Durabla will keep your Flanges tight and give you Lasting Service.

DURABLA MANUFACTURING COMPANY

New York

Canadian Distributors:
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Toronto Montreal Winnipeg Calgary Vancouver Windsor St. John Victoria Ottawa

POSITIVE PROOF

of careful firing or uniformity of any pressures can best be obtained by use of

American Recording Gauges

Why not encourage careful operation by installing these instruments?

Descriptive pamphlet on request.

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American Steam Gauge and Valve Mfg. Co.

New York Chicago BOSTON Atlanta Pittsburgh

MARTELL PACKINGS MEAN MORE POWER

Ask "the man who knows" in any power plant what he thinks of the Martell Packings. We will leave it to his verdict. Power House experts know the worth of these packings by their good name or by actual experience with them.

Failure is out of the question with these packings.

Cut at a tangent to piston rod, and joints on diametrically opposite sides of piston are parallel. This arrangement of the joints of the ring allows the parts to adjust themselves to slight inequality of wear in the diameter of the rod, as they float freely. Therein lies superiority of Martell packings. WHY NOT GIVE THEM A TRIAL?

The Martell Packings Company, Inc., Elyria, Ohio

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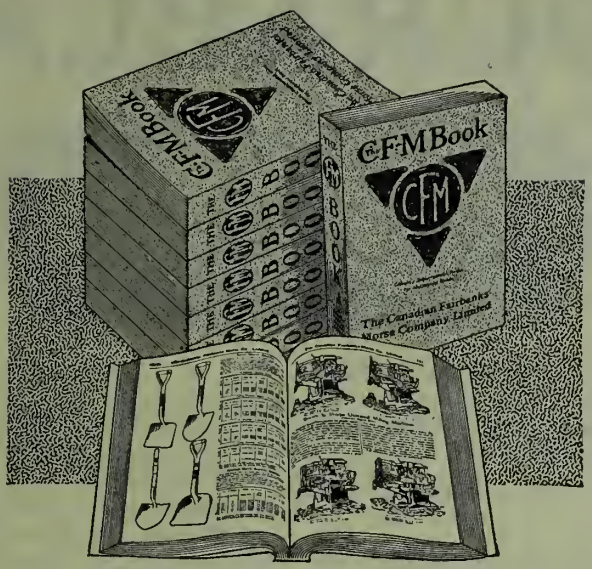

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On saturated and superheated steam, High and Low Pressures, Air, Gas, Oil and Ammonia, Durabla will keep your Flanges tight and give you Lasting Service.

DURABLA MANUFACTURING COMPANY

New York

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Toronto Montreal Winnipeg Calgary Vancouver Windsor St. John Victoria Ottawa

POSITIVE PROOF

of careful firing or uniformity of any pressures can best be obtained by use of

American Recording Gauges

Why not encourage careful operation by installing these instruments?

Descriptive pamphlet on request.

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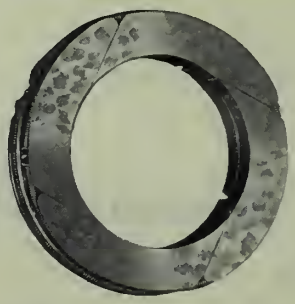

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Neither the shortage, nor the high price of raw materials, due to war conditions, have been allowed to interfere in any way with the long-established quality of "PALMETTO" Packing, nor with the customary shipping of orders the same day as they are received.

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Why not let us send you a free working sample to prove quality—no charge.

GREENE, TWEED & CO., *Sole Manufacturers*
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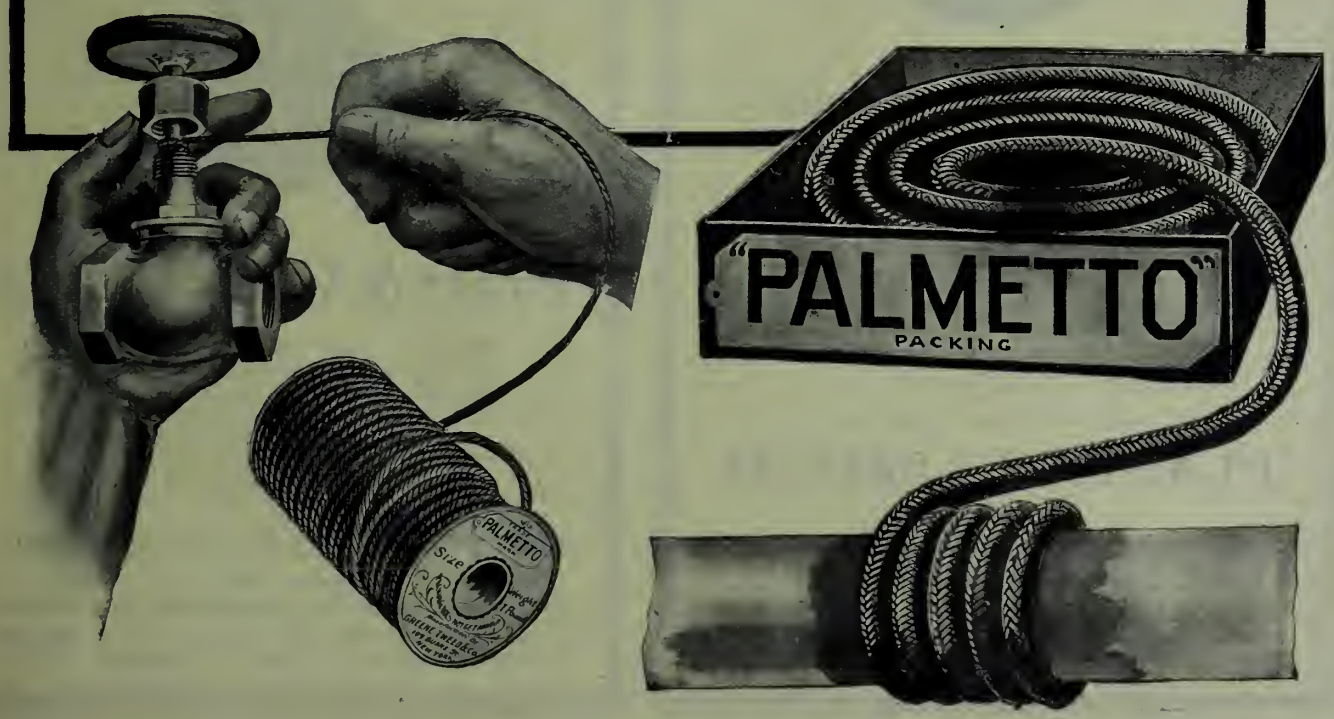

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That's the Reason Why ALBERGER MULTI-HEAD HEATER is Extensively Used in the Biggest and Best Equipped Factories, Institutions, Hospitals, Office Buildings.

Dangerous strains on the tubes and tube heads are eliminated by our

Double Floating Tube Heads

With these tube heads the tubes can expand or contract entirely independent of shell, thereby accommodating differential expansion.

Corrugated Copper Tubes eliminate collection of materials and prevent splitting, common with brass tubes.

Tubes are always clean and free from scale—increasing heat unit by 50% over straight tubes.

Write for complete description of its merits. It will pay you.

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25,000 to 30,000 OPENINGS WITHOUT INJURY

A wonderful record performed under most severe conditions with a leaky valve, and wet steam, by

Bakelite Discs

The saving in Disc cost secured by the use of Bakelite Discs on Fairbanks Valves has led us to produce a complete range of discs for the Jenkins type Valves.

All sizes ready for immediate delivery.

Specify "Bakelite" Discs on your next order.

PLASTICS LIMITED

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The Canadian Fairbanks-Morse Co.
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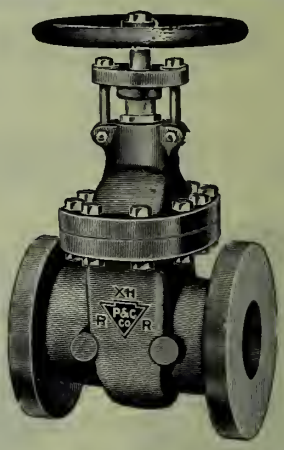

Pratt & Cady Valves

Wherever they are used are always selected because of their durability and strength. For the past forty years the most progressive engineers in this country have conceded their superiority. They are made for every service and in many patterns and weights. Ask for our catalog.

PRATT & CADY CO., Hartford, Conn, U.S.A.

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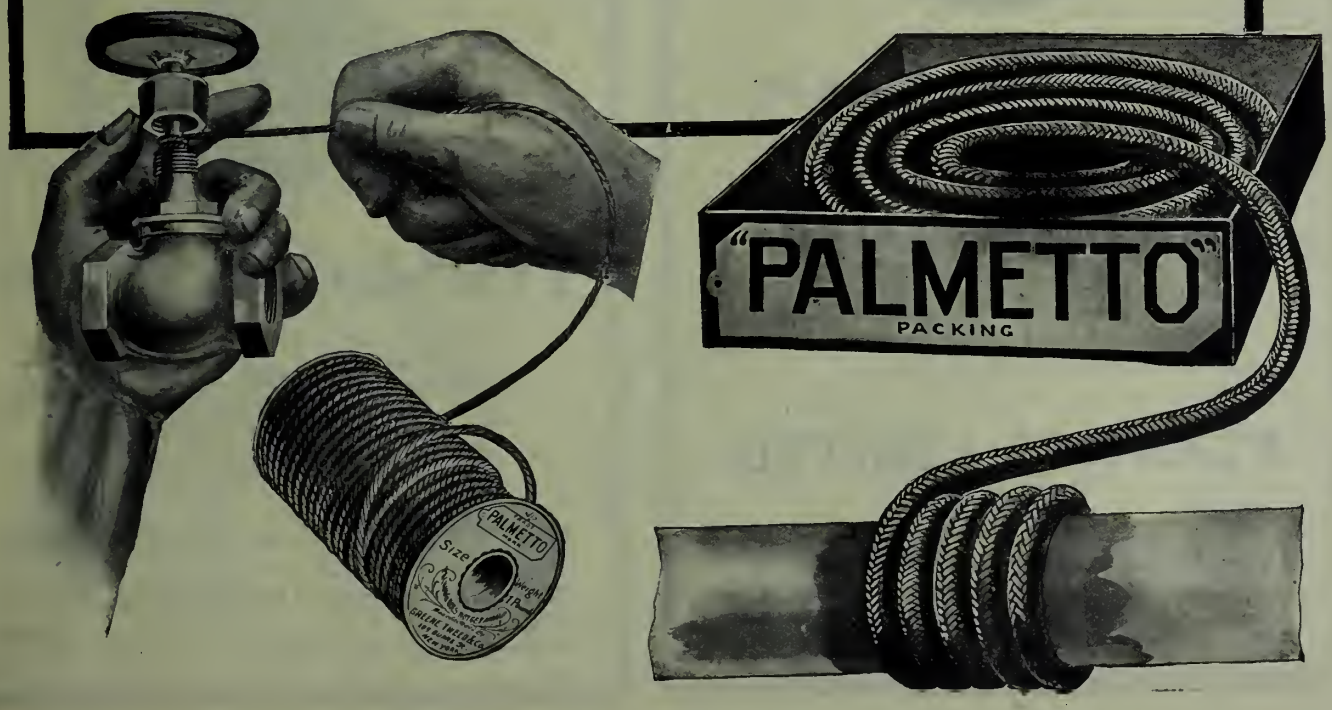

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25,000 to 30,000 OPENINGS WITHOUT INJURY

A wonderful record performed under most severe conditions with a leaky valve, and wet steam, by

Bakelite Discs

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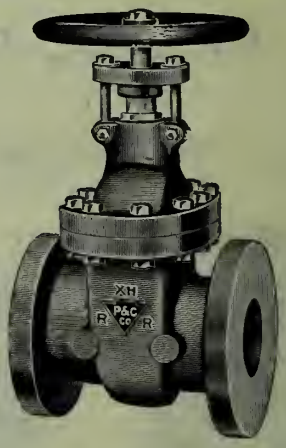

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14-in. Graton & Knight Quarter-turn Drive in the Donovan Lumber Co., Aberdeen Wash.

GRATON & KNIGHT
Standardized Series
LEATHER BELTING

Tanned by us for belting use

Graton & Knight Bigness insures Graton & Knight uniformity

Graton & Knight Leather Beltings are uniform—

Because Graton & Knight are the largest belt makers, because they purchase and tan 285,000 hides a year, because their brands are selected and graded to the highest degree of uniformity from this enormous supply of raw material.

Uniformity is the most important factor in belting quality. A belt, like a chain, is no better than its poorest piece.

* * *

Only a big firm like Graton & Knight could establisb and maintain an equal degree of uniformity in its belting.
And Graton & Knight are the largest leatber belt makers in America.
This minute control of uniformity is possible only because of their large supply of leatber tanned by tbem for belting use. A smaller supply would prove a constant temptation to put dissimilar pieces of leather into the same belt.
Graton & Knight bides are tanned in the Graton & Knigbt tannery, especially for belting purposes, by processes perfected in 53 years of belting tannage. It would be impossible for them to maintain equal uniformity if they used several different tannages.
Finally, Graton & Knight in the manufacture of tbeir by-products use bellies, shoulders, and otber parts of hides not suited for belting—tbere is no temptation to include these in Graton & Knight Belting.

* * *

Tbis is wby Graton & Knight can make a complete and standardized series of leatber belting; and maintain so high and so fixed a degree of uniformity in eacb brand.
It is wby Graton & Knight First Quality **means** first quality—absolutely free from any mixture of seconds, shoulders or worse.

This is no time to experiment

with untried belting. High-speed production and continuous operation demand the *known* quality, the *proved* strength and ruggedness which have been built into Graton & Knight Leather Beltings for three generations.

The Graton & Knight Book on Belting is authority on modern belting practice. Write for a copy to-day.

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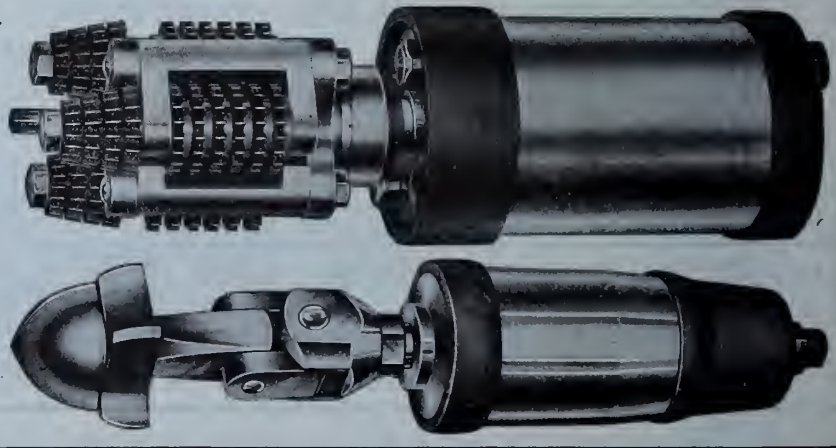

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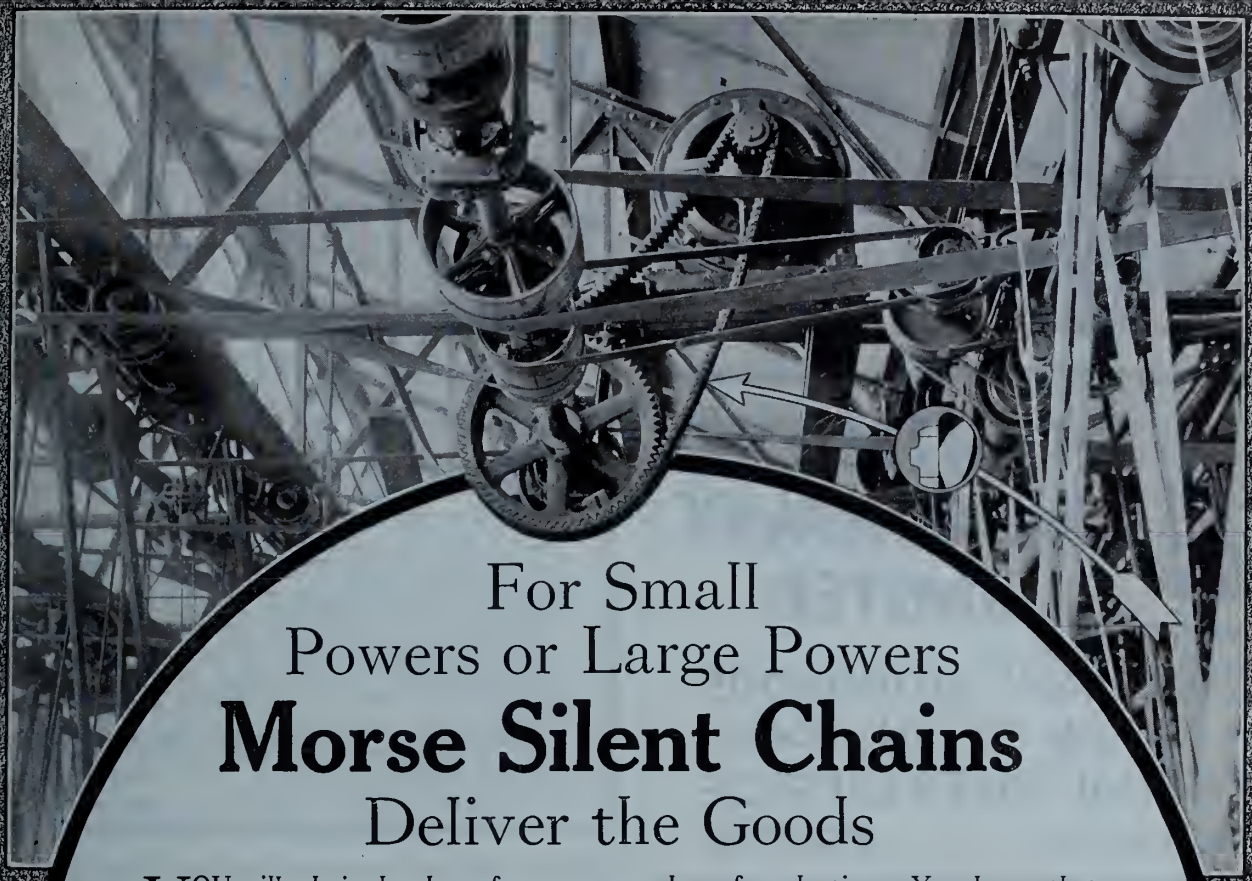

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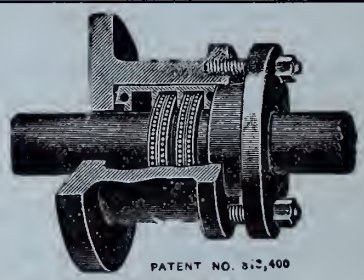

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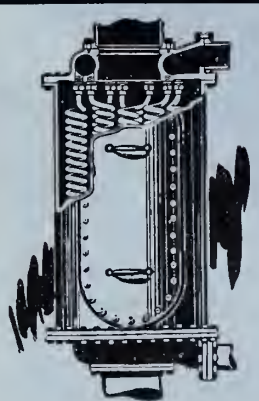

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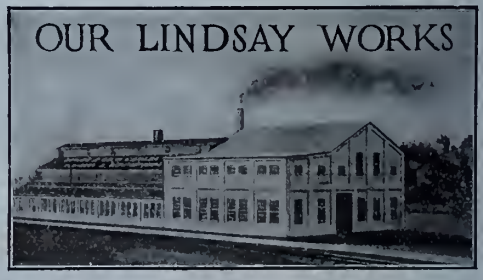

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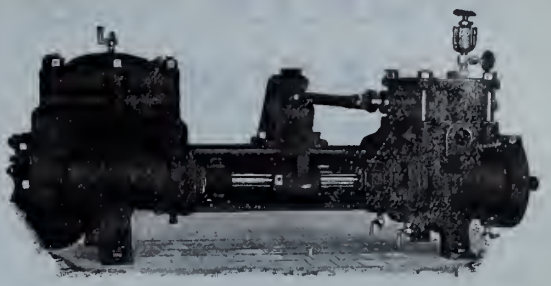

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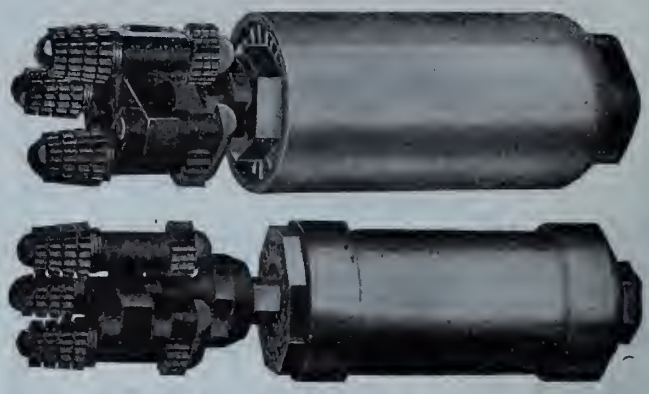

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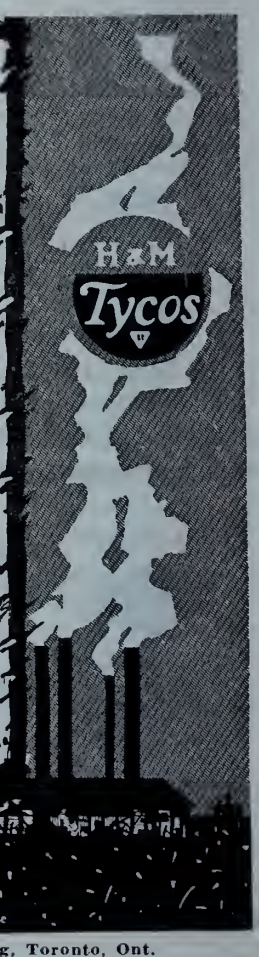

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York Manufacturing Co., York, Pa.

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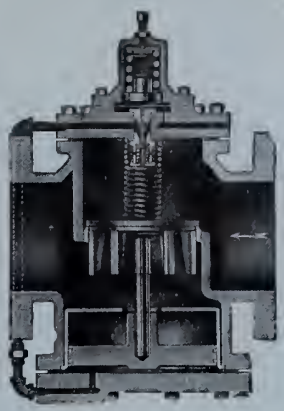

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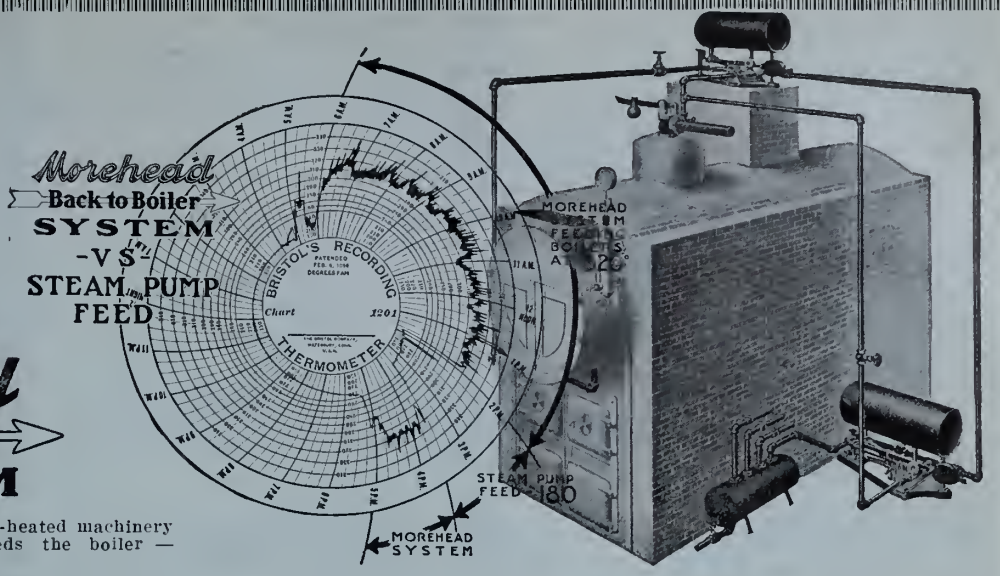

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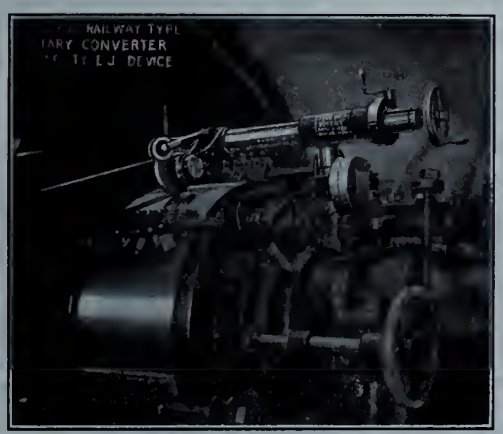

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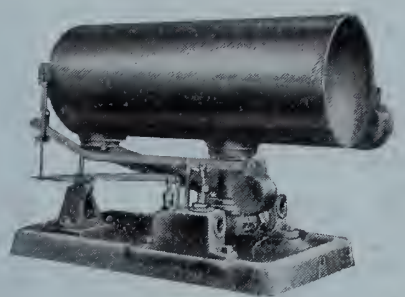

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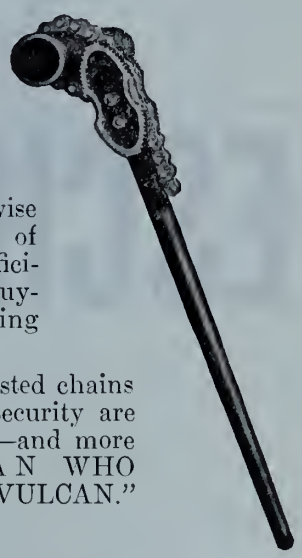

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Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator Co., Boston, Mass.
McAvity & Sons, T., St. John, N.B.
Morrison, Jas., Brass Mfg. Co., Toronto, Ont.
Penherthy Injector Co., Windsor, Ont.
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Pratt & Cady, Hartford, Conn.
Watson & McDaniel Co., Philadelphia.
York Manufacturing Co., York, Pa.

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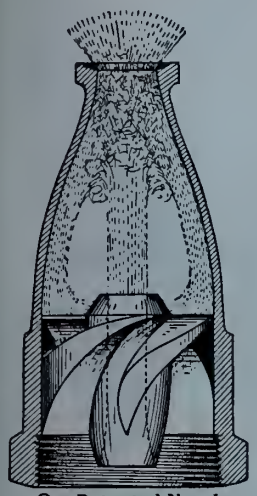

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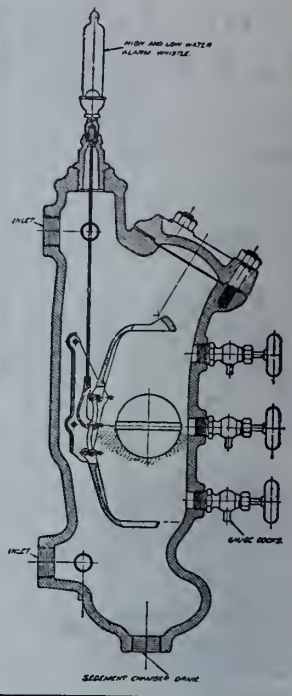

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The entire mechanism is assembled as a single unit, a removable hanger frame, and hung on accurately machined bronze pivots.

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INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 59
Alberger Heater Co. 68
American Steam Gauge & Valve Mfg. Co. 66
American Steam Pump Co.... 13
Anderson Co., V. D. 86
Armstrong Cork Insulation Co. 9

B

Babbitt Steam Specialty Co.. 72
Babcock & Wilcox 76
Bawden Machine Co., Ltd..... 7
Beveridge Paper Co. 59
Boiler Inspection Dept. 75
Boving Hydraulic & Eng. Co.. 74
Bowser, S. F., & Co., Inc..... 63

C

Can. B. K. Morton Co..... 12
Can. Detroit Lub. Co. 59
Can. Fairbanks-Morse Co. 65
Can. Griscom-Russell Co., Ltd. 74
Can. H. W. Johns-Manville Co., Ltd. 58
Can. Morehead Mfg. Co. 81
Can. Sirocco Co. 81
Can. S K F Co. 70
Chaplin-Fulton Co. 52
Cling-Surface Co. 63
Coe Co., C. T. 54
Coppus Eng. & Equip. Co..... 7
Crown Mfg. Co. 53

D

Darling Bros. 13
Dart Union Co. 56
Davis Regulator Co. 55
D'Este Co., Julian 85
De Laval Steam Turbine Co... 62
Direct Separator Co. 71
Dixon Crucible Co., Jos. 50
Dominion Belting Co. 72
Dominion Coal Co. 74
Durabla Mfg. Co. 66

PAGE

E

Economy Fuse & Mfg. Co. of Canada 62
Escher Wyss & Co. 84

F

Foxboro Co. 76
Francis, Walter J., & Co. 50
Frick Co. 9

G

Galt Foundry Co. 5
Garlock Packing Co. 60
Garth Co. 74
Gates, John W. 51
Goldie & McCulloch Co. 16
Graton & Knight Mfg. Co..... 69
Greene, Tweed & Co. 67

H

Hoffman, G. W. 51
Holmes Metallic Packing Co.. 74
Homestead Valve Mfg. Co. 85
Hoyt Metal Co. 2

I

Inglis Co., John..Inside back cover

J ..

Jamison Cold Storage Door Co. 10
Jeffrey Mfg. Co. 52
Jenckes Machine Co. 2
Jenkins Bros. 3
Jones Underfeed Stoker Co., Ltd. 4
Jordan Bros., Inc. 81

K

Kerr Engine Co. 57

PAGE

L

Ladd, The Geo., Co. 75
Laurie & Lamb 11
Leitch Co., The Arthur S..... 79
Liberty Mfg. Co. 47
Linde Canadian Refrigeration Works Co..... 8
Lunkenheimer 57
Lyman Tube & Supply Co.... 79

M

MacGovern & Co. 83
MacKinnon, Holmes & Co. ... 50
Magnolia Metal Co. 71
Martel Packings Co. 66
Mason Regulator Co. ....
McAvity & Sons, T. 54
McDougall Caledonian Iron Works Co. 14
McGhie, W. C. 74
McLaren, D. K., Ltd. 61
Morris Machine Works 62
Morrison Brass Mfg. Co., Jas.. Outside back cover
Morse Chain Co. 73
Murphy Iron Works 4

N

Nashua Mach. Works 6

P

Pecrless Rubber Co. ..... Inside front cover
Peiler & Co., H. L. 6
Penberthy Injector Co., Ltd... Outside front cover
Pennsylvania Flexible Metallic Tubing Co. 71
Pierce Co., Wm. B. 53
Plastics, Ltd. 68
Pratt & Cady Co. 68
Pulsometer Engineering Co. .. 49

PAGE

R

Roto Company, The 72

S

Sarco Co., Inc. 51
"S-C" Regulator Co., The.... 52
Scaife, Wm. B., & Sons Co... 84
Schaeffer & Budenberg Mfg. Co. 7
A S K Chemical Co. 51
Smart-Turner Mach. Co. 75
Smith, Fred 75
Snowdon, C. C. 64
Spray Engineering Co. 85
Starrett, L. S., Co. 63
Steel Mill Packing Co. 75
Storey Pump & Equipment Co. 62
Sturtevant, B. F., Co., of Canada 49

T

Taylor Instrument Co. 76
Thomas Grate Bar Co. 5
Trimont Manufacturing Co.... 83
Turbine Equipment Co., Toronto 62

U

Uehling Instrument Co. 79

V

Vilter Mfg. Co. 8

W

Wall, W. J. 51
Waterous Engine Works Co... 1
Watson & McDaniel Co. 76
Williams & Co., J. H. 83

Y

York Mfg. Co. 10

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Vol X Publication Office, Toronto—May, 1917 No. 5

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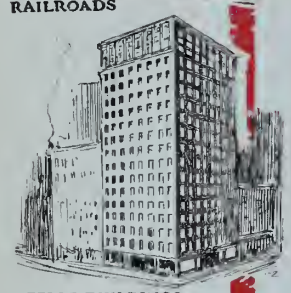

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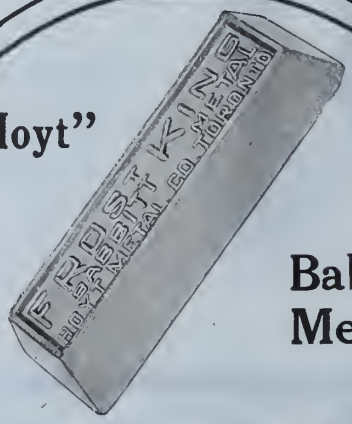

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Fig. 300
Type "K"
Brass Gate Valve
Screwed
Outside View

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TYPE "K"

BRASS GATE VALVES

approved and registered for use in Ontario and the Western Provinces by the Departments of Public Works for working steam pressures up to 125 pounds.

Registration	*Numbers*
Alberta	No. 439
Ontario	No. 45
Saskatchewan	No. 2155

Fig. 300
Type "K"
Brass Gate Valve
Screwed
Sectional View

Type "K" Brass Gate Valves

are made from the best material we can buy, and combined with careful manufacturing, are the best Gate Valves on the market.

The double compensating bronze discs in Type "K" Brass Gate Valves produce a mechanism which is unequalled for ease of operation and perfect closing.

Type "K" Gate Valves can be placed in any position without fear of jamming.

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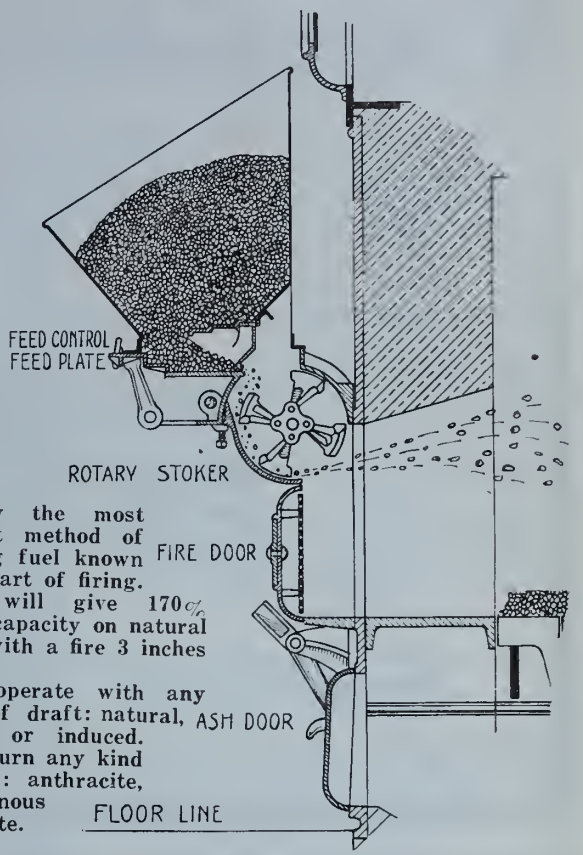

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combine Power, Simplicity and Efficiency

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Manufacturers
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Pump Regulator
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Damper Regulators

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Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

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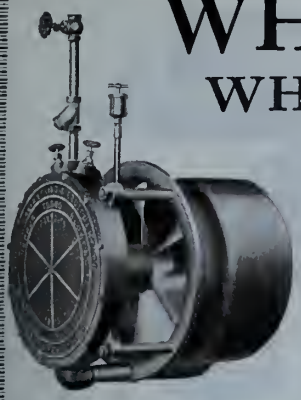

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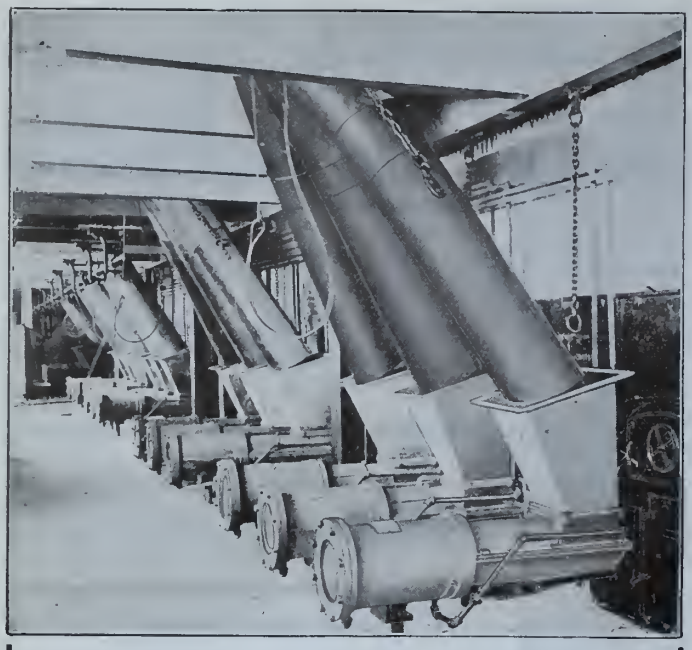

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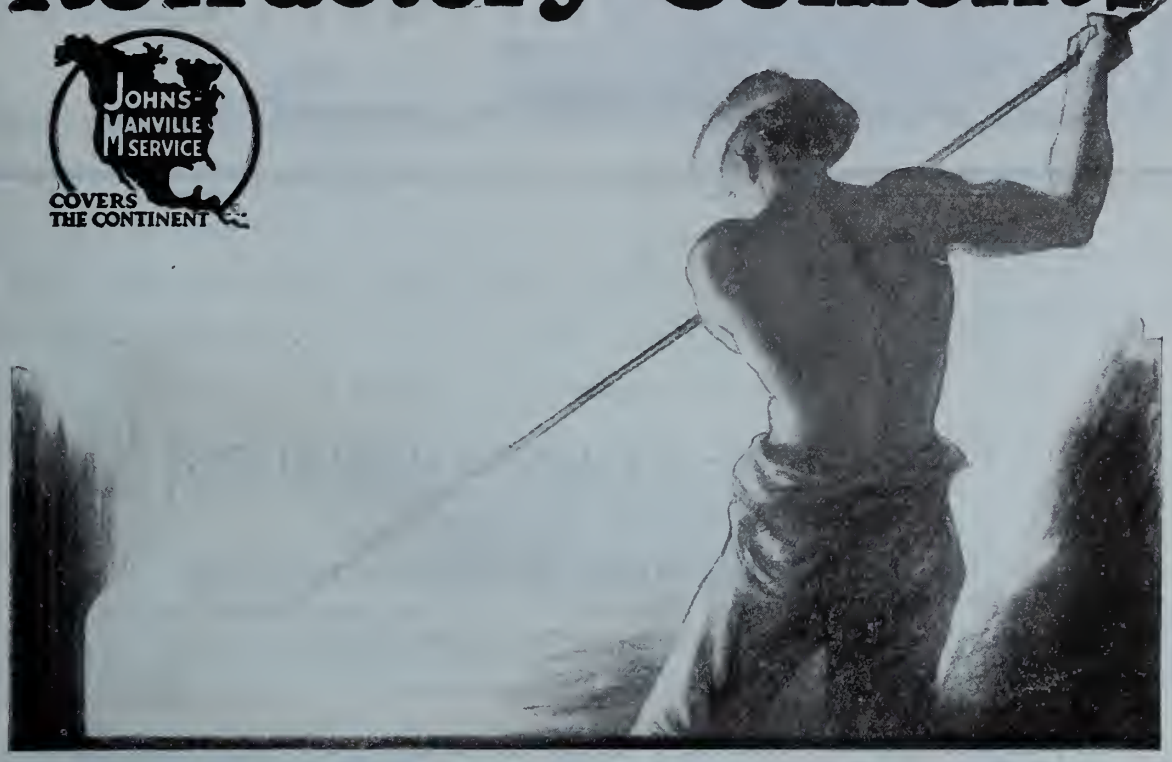

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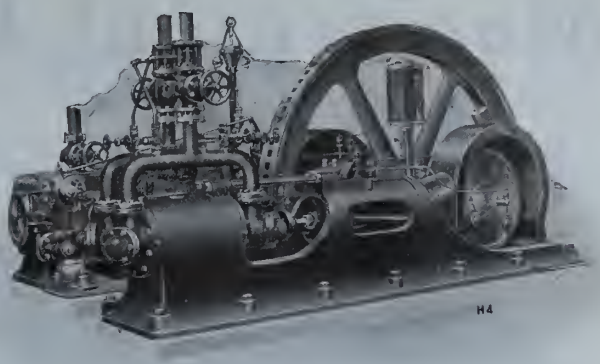

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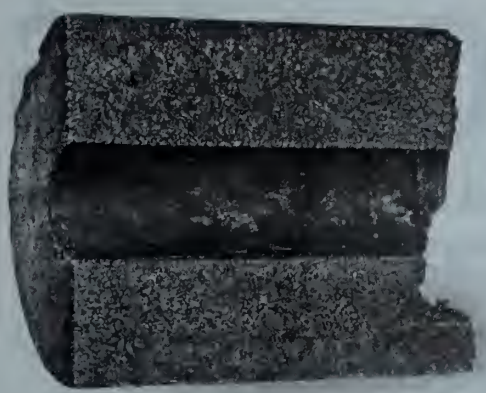

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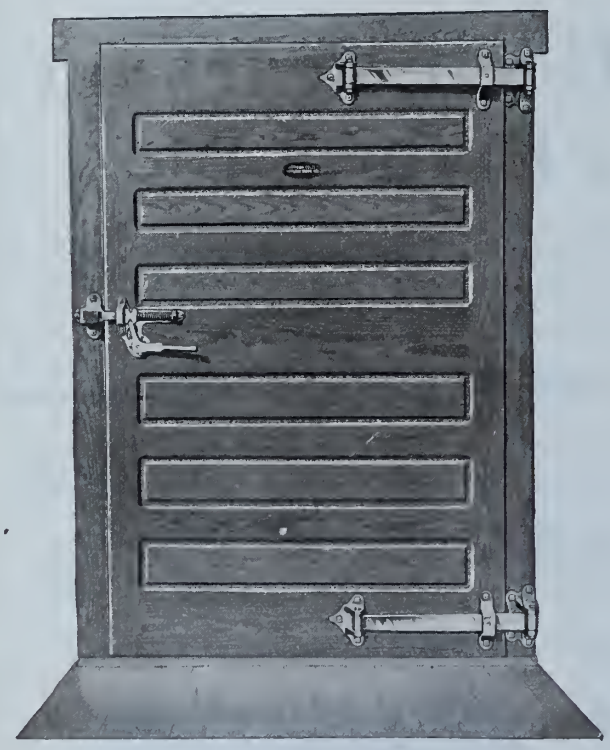

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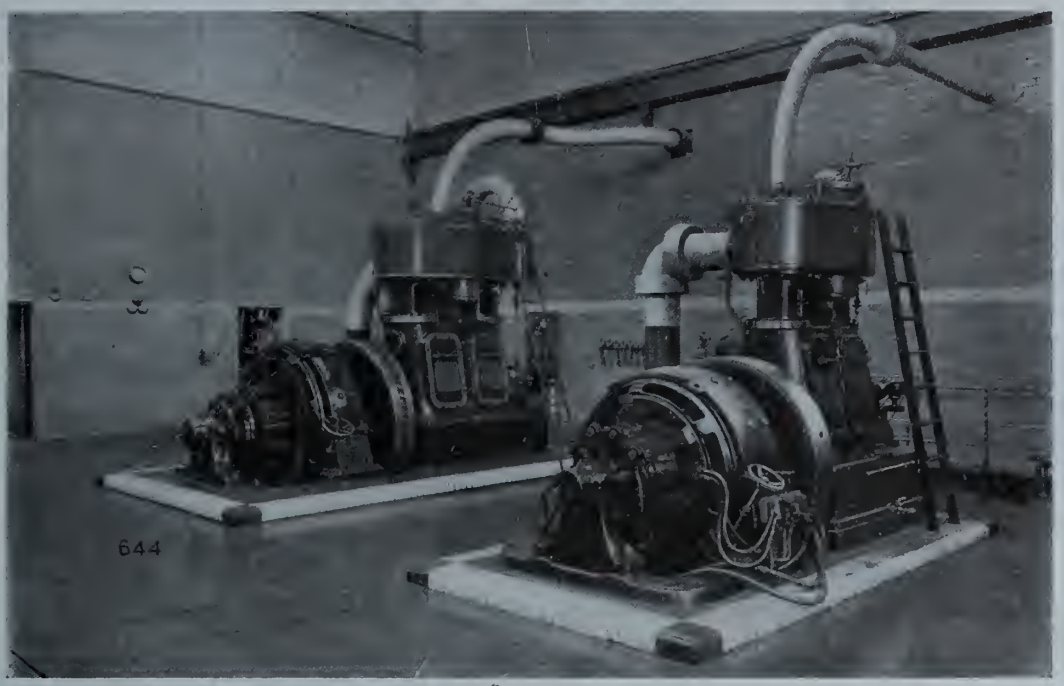

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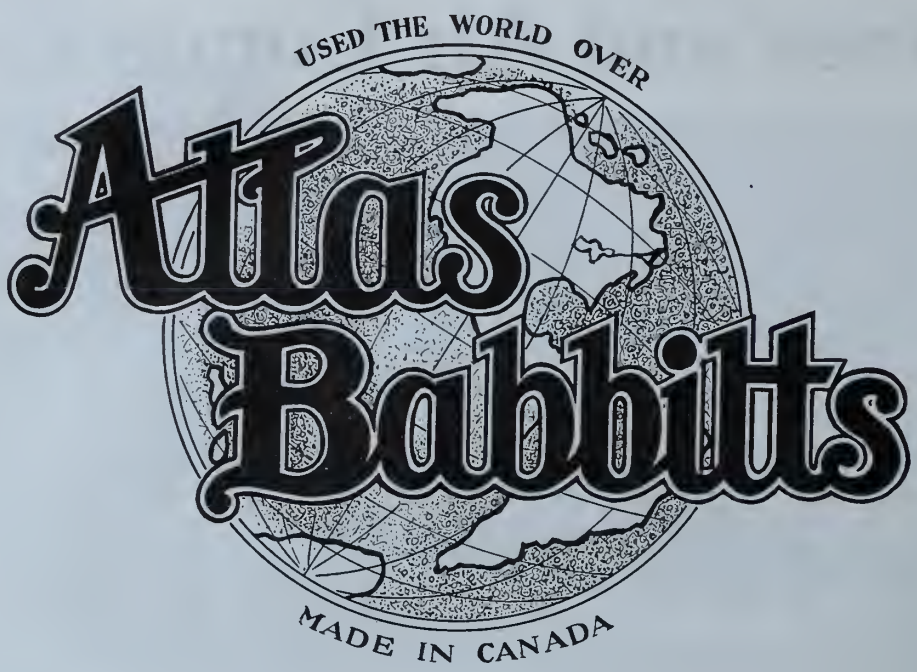

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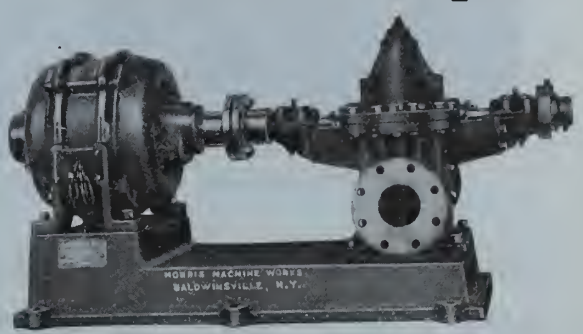

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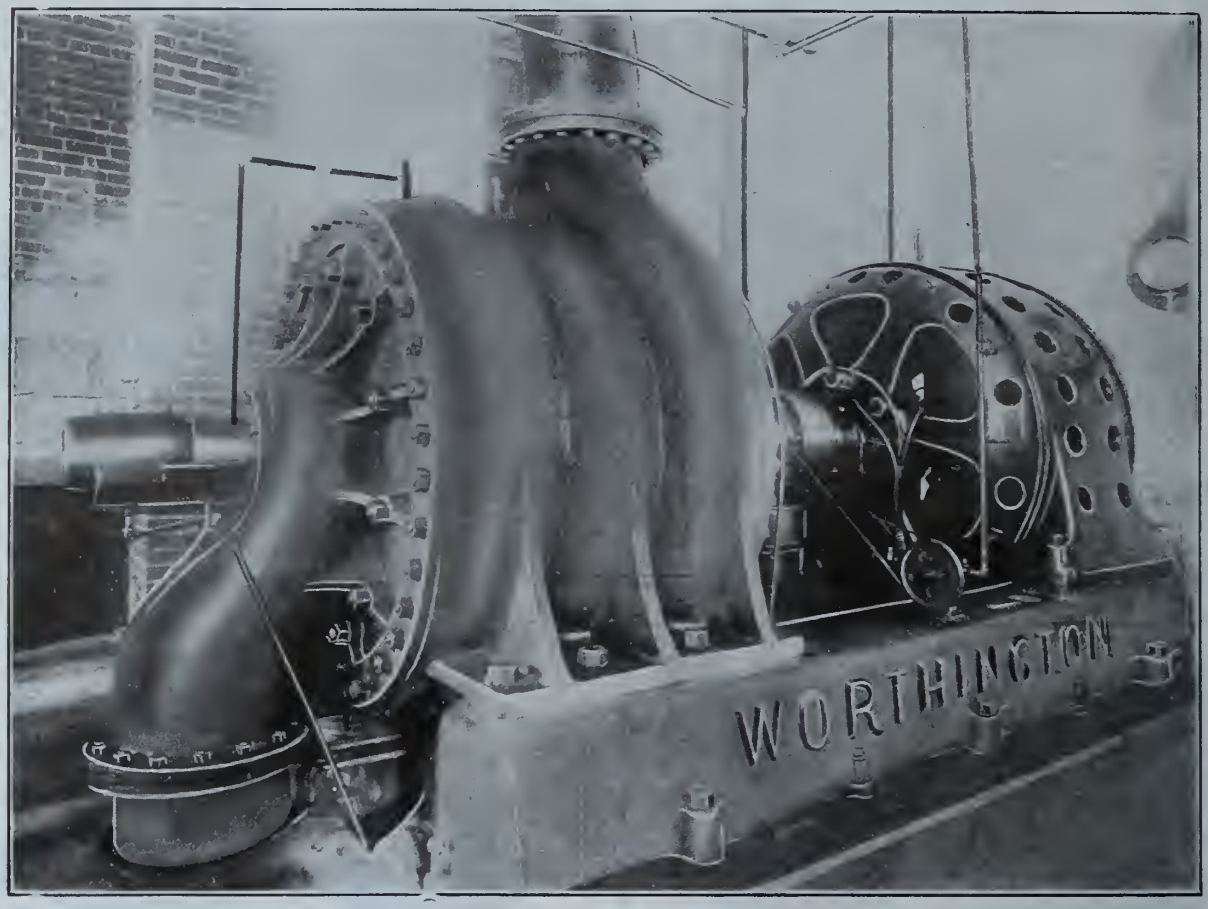

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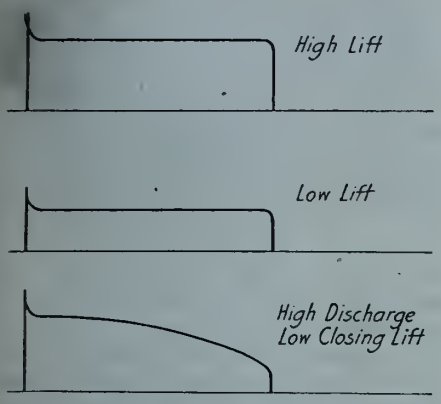
Development Towards New Type of Steam Safety Valves *

By George H. Clark **

The article presents in outline the theoretical considerations governing safety-valve action, and gives a record of experimental work done in the development of a new type of safety valve. In discussing the new type of valve here presented, actual diagrams of valve action have been introduced, together with results of capacity tests of sufficient duration to insure accuracy. An attempt is made to show that the efficiency of valves may be increased materially by using the proper design of seat, and that with two regulating rings instead of one as is usual, variations of advantageous character may be introduced into the valve action.

IN order to develop a safety valve of high discharge capacity at the greatest possible efficiency, and with the least possible weight of valve per pound of discharge, it is clear that, for any given diameter of valve seat, the one



FIGS. 1, 2, 3. DIAGRAMS OF LIFT CHARACTERISTICS.

giving the greatest lift will have the greatest discharge capacity if the seat angles are equal, and, with equal lifts and equal diameters, the flat seat (at right angles to perpendicular axis) is the most efficient. The flat seat was adopted at the start, due to its greater efficiency and to other considerations, to be mentioned later, and effort was directed toward methods of increasing the lifts, at the same time retaining all the advantageous factors obtaining in low-lift valves.

The two most serious objections to high-lift valves are the shock produced at closure and the tendency to lift water. There has been almost endless discussion over these points, resulting in more or less misunderstanding. The shock of closure depends on the height from which the disk drops to its seat and the velocity with which it is moving at the time it seats. By reducing the height from which the disk drops, the shock may be reduced so that the valve having an enormous lift after popping may close without shock if that lift decreases gradually with the receding pressure until it becomes small at the point of closure. This point has been very clearly brought to the experimenter, although no record is available, since the shock cannot be measured.

The second objection to high-lift valves, that of lifting water, is in reality less serious. It is useless for anyone to say that this objection is unfounded, because the tendency to lift water is almost entirely dependent upon the capacity of the valve, and the higher the lift the greater the capacity. It must, however, be remembered that every steam boiler has a certain required safety-valve capacity which is the same for all classes of valve, so that for proper relief the total capacity of the low-lift installation and the high-lift installation is one and the same. Now if the capacities are the same, the velocities in the boiler nozzles are the same, and one has no greater tendency than the other to lift water, since the rise in water level is due to velocity toward the nozzle. The two objections spoken of above may exist in high-lift valves, if, in the first case, the valve lacks the proper action, and in the second case if judgment is not used in the installation.

The results of shock are injury to the boiler and a short valve life, and if felt necessary this may be avoided, not by eliminating the high-lift valves, but by legislating against their bad feature, high closing lift. The lifting of water seldom occurs with stationary boilers, and it can be prevented by the proper choice of valve nozzle and of discharge capacity per valve. Fig. 1 shows the characteristic of certain high-lift valves which are objectionable, due to the high closing lift. Fig. 2 shows that of a low-lift valve in which the high closing lift has been obviated at the expense of discharge capacity. Fig. 3 shows the characteristic of an ideal valve having high capacity and low closing lift, and this was decided upon as the aim of the investigation.

Relation Between Discharge and Pressure Under Valve Disk.

In order to investigate the subject thoroughly, it is necessary to take into account two forces which produce valve action, not the least important of which

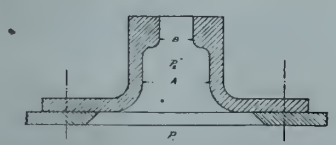


FIG. 4. REDUCTION IN AREA OF PASSAGE BETWEEN BOILER AND VALVE.

is the variation in pressure on the spring-load area of the disk—in other words, the pressure which exists below the disk in advance of and during the period of blowing. By means of certain assumptions we can apply the formula of flow proposed by Napier, and after the calculations are made they may be tempered by the actual conditions which exist, should they deviate from the assumptions.

Steam in the course of its passage

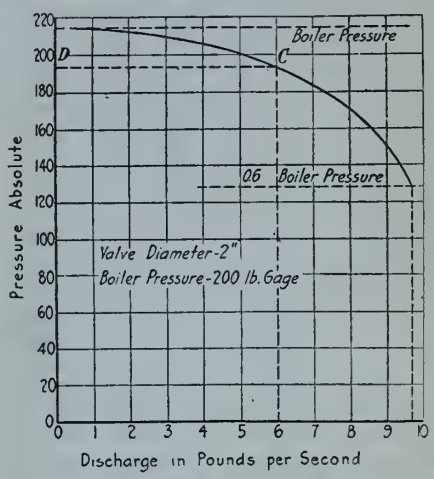


FIG. 5. RELATION BETWEEN PRESSURE UNDER DISK AND WEIGHT OF STEAM FLOWING.

from the boiler to the atmosphere encounters two reductions in area of passage which affect the pressure under the disk, one at entrance to the valve or the nozzle, and the other at the seat. The existent area conditions may be graphically represented by Fig. 4, in which the reduction of area from boiler to valve is denoted by the section at A, and over the seat by the section at B. The edges of the passage which form the approach to the section at A are rounded to a radius equal to the diameter of the passage, in order that the formula used may fit the case at hand. Let P_1 represent the boiler pressure, P_2 the pressure under the disk, and then assume that by some means the area at B can be changed as desired. When flow is established and conditions have become constant, the weight of steam passing the section B is the same as that passing the section A, and if the weight passing B is varied, that passing A goes through the same variation. Now the pressure P_2 depends on the weight flowing and the pressure P_1. Assign a constant value to P_1, say 200 lb. absolute, and by means of the following formula calculate the pressure P_2 with different weights flowing. So long as the discharge capacity at B is less than that at A, the formula

$$W = 0.029\ a\ \sqrt{P_2}\ (P_1 - P_2)$$

holds. When P_1 is assumed to be constant the formula may be written:

*From paper presented at annual meeting of American Society of Mechanical Engineers.

**Instructor in Mechanical Engineering, Massachusetts Institute of Technology.

$$P_2 = \frac{P_1}{2} + \text{or} - \sqrt{\frac{P_2}{2} - \frac{W}{(0.029\ a^2)}}$$

after the quadratic equation has been solved.

Assume now, for an actual case, that the diameter at A is 2 in., giving an area 3.1416 sq. in., and that P_1 is equal to 200 lb. absolute boiler pressure. Then calculate different values of P_2 with different weights flowing. These values of P_2 may be plotted against the weights, and the curve shown by Fig. 5 will result. This curve is interesting, since it represents quantities which may be arrived at by calculation only, and which must exist. Its significance is as follows:

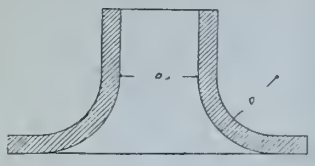


FIG. 6. STANDARD ORIFICE.

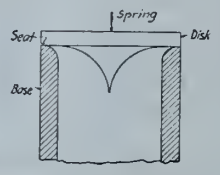


FIG. 7. VALVE INCORPORATING STANDARD ORIFICE EQUIVALENT.

With a safety valve of 2 in. nominal diameter and adapted to discharge a certain weight of steam, the pressure under its disk may be found from the curve in the following manner: Suppose its discharge is 6 lb. per sec.; then the points C and D are located and the pressure under the disk may be read. It is clear then from this curve that the pressure under the disk varies as the weight of flow varies; and that for valves of low lift the reduction of pressure is not great, but that for high lifts it increases rapidly. This curve is discontinuous when the pressure under the disk reaches a point where it is equal to 0.6 × boiler pressure, under which condition the area at B has become equal to that at A; the pressure P_2 is the minimum possible, and to all intents and purposes we have a standard orifice, so-called, the characteristics of which are shown by Fig. 6.

Our only assumptions up to the present are the neglect of friction and the rounded edges. It is clear that friction and square edges will tend to increase the drop in pressure, since both tend to reduce the discharge capacity of A, and it also follows that maximum capacity is not available with square edges at A. In other words, the full advantage of the hole in the boiler is not available unless this hole has rounded edges.

There results from the further consideration of the curve in Fig. 5 a simple explanation of why a safety-valve disk settles back after the first sudden pop. Since the reduction of pressure on the disk does not take place until the valve is open or until flow is established, the lifting force is, at opening, that due to full boiler pressure and, the instant flow is established, this is reduced and the disk must necessarily settle back to a position of equilibrium. The design of a valve must then incorporate means to provide lifting force outside the seat area, to make up for the reduction of upward force on the load area due to drop in pressure over and above that necessary to compress the spring.

In any safety valve there are three factors which affect the rate of flow over the seat, and which are characteristic of the seat itself. They are vertical lift, seat angle, and the contour of the passage which approaches the seat. The flat seat is adapted to open the largest area per unit of vertical lift, and hence should be employed, all other things being equal. Since the approach to a standard orifice makes the throat sectional area 100 per cent. efficient, the characteristics of such an orifice should be employed. Professor E. F. Miller, of the Massachusetts Institute of Technology, was first to round the edges of a safety valve in order to increase the efficiency of discharge per unit of lift, and in so doing took a long step in the direction of high safety-valve efficiency. The valve shown in Fig. 7, in which the standard orifice (or better, its practical equivalent), is incorporated, follows the theory proposed by him several years ago. The full benefit of the standard orifice would be available, regardless of the type of lip provided, if the passage area from the seat outward increased; but to produce a high-lift valve the maximum available pressure between the lips consistent with maximum discharge must be used.

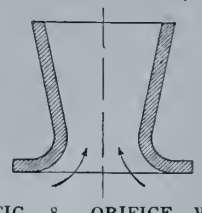


FIG. 8. ORIFICE WITH PRESSURE BEYOND THROAT VARYING INVERSELY AS AREA.

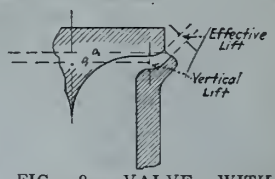


FIG. 9. VALVE WITH MAXIMUM PRESSURE BETWEEN LIPS.

Steam Flow as Affected by Shape of Orifice

A consideration of the pressure conditions within a standard orifice, of which Fig. 6 is an example, will give valuable information. In this type of orifice the area of each section beyond the throat section is equal to that at the throat section; and it has been found that at the throat section and at each section of equal area thereafter the pressure is very closely equal to 0.6 × boiler pressure, and that the back pressure into which this orifice discharges has no effect on either the weight discharged or the existent orifice pressures unless this back pressure exceeds 0.6 × boiler pressure. If it does exceed 0.6 × boiler pressure, the discharge capacity is reduced and the pressure throughout the orifice is increased. With the orifice of a shape shown in Fig. 8, but of equal throat-sectional area, the weight discharged is the same as before, but the pressure after the throat section varies inversely as the area.

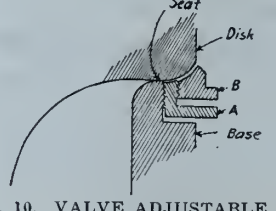


FIG. 10. VALVE ADJUSTABLE FOR VARIABLE LIFTING FORCE.

It follows from the above consideration that in order to produce maximum pressure between the lips there must exist at full lift an equality of area at each section outward from the throat of the orifice which is located at the seat. Since the effective disk diameters are constantly increasing, the effective lift must be reduced as the passage is lengthened. This can be done by giving the passage an upward slope, as shown by Fig. 9, which illustrates graphically the reduction of effective lift with increasing diameters such as D_1 and D_2, at which the vertical and effective lifts are measured.

If a valve of the above characteristics is constructed and blown, it will be found to have an extremely high lift, and the opening of such a valve is so sudden as to be truly explosive. A very large percentage of the pop lift is sustained if the popping pressure is held constant, and when such a valve starts to blow down, the lift gradually decreases during the blow-down period until a certain point is reached where the pressure becomes such that the valve disk drops suddenly to closure. This construction will produce a blow-down which is likely to be a third of the boiler pressure, and forces its designer to incorporate means of regulation which will give a small blow-down without interfering with the capacity or other features of valve action.

Regulation for Warning and Blow-down

The question of adjustment presents the real difficulty in safety-valve design. Means for regulation should in general perform their functions with as little effect as is possible on the lift and, per unit of lift, should produce no effect on the discharge capacity. Other than lift the two functions to be controlled by regulation of the variations in lifting force are warning and blow-down. A valve which chatters or vibrates at the instant of opening, or sizzles at that time, shows a lack of lifting force at low lifts, and one which shows an excessive blow-down demonstrates that the lifting force at low lifts is too great to allow of closure, and it follows that the requirements of warning and blow-down are somewhat combative. If possible the regulation of one should be made independent of the other. Blow-down is an absolute necessity on the spring-loaded type, due to the existence of lifting force outside

the spring chamber, and it is clear that attempts to reduce the blow-down will tend to decrease the lift and relieving capacity. In general, the real secret in the

FIG. 11. VALVE ARRANGED FOR TEST.

design of a perfect safety valve lies, not in the production of excessive lifting force, but in controlling and adjusting it; the action of a valve is dependent, not on the quantity of lifting force, but on variations of lifting force with discharge capacity and pressure.

Design of New Valve

Fig. 10 shows a valve having means for adjustment which are based on the production of variable lifting force as stated above. The two annular rings shown at A and B carry on their upper surfaces curves which approximate in shape the curve of the disk. The inner ring A, which I choose to call the warning ring, is threaded upon the base of the valve just outside the flat seat and carries, threaded upon it, the ring B, which is adapted to control the blow-down. These rings may be lowered away from the disk, or given what I choose to call initial clearance.

Now it is clear that if both of these rings are lowered an extreme distance, when the valve tends to open no lifting force will be available. If the ring A is raised to a position near the valve disk,

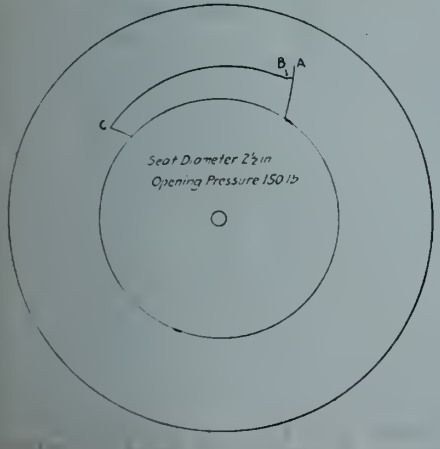


FIG. 12. PERFORMANCE CHART OF 2½ INS. EXPERIMENTAL VALVE.

a lifting force will be provided which will depend (1) on the pressure produced between it and the disk and (2) on the extent of the disk area on which this pressure acts. As was shown in the discussion of the standard orifice, the pressure depends on the area of the passage, and the area in the valve is a function of the initial clearance and the shape of the curve. These factors are built into the valve to produce the desired result, which is to provide lifting force at small lifts to overcome excessive warning; and it has been found that with the proper shape of ring, on its initial clearance depends the warning of the valve. Since this warning ring alone produces only small lifts, it has no appreciable effect on the blow-down.

Again, as the blow-down ring B is raised from its lowest position, there is a tendency to build up pressure between it and the disk when the valve is open, which tendency increases as the disk is approached. If a reasonably large clearance is left, it is clear that this ring produces almost no lifting force at low lift, since the area of the passage along this ring is large in comparison to that over the seat; and it follows also that, as the disk lifts, the effect of its initial clearance on the area of the passage becomes less and less as lifting continues. This can be illustrated by a simple calculation. Suppose that, measured at the extreme outside edge of this ring, the initial clearance is 0.03 in. and that the angle at this point is 45 deg.; then if the disk lifts 0.1 in. in a vertical direction, the height of the passage over the seat will be 0.1 in., and at the extreme edge the increase in passage height perpendicular to the curves will be 0.07 in., since with a 45-deg. angle the vertical lift is only seven-tenths effective—so that the total height of the passage is 0.1 in., the same as that over the seat. Suppose now that the lifting continues; the area at the edge of this ring gradually approaches that over the seat and can be made to become equal to it by proper design at any chosen lift. It is clear then that for all of the initial clearance of the rings, we have at full lift gotten back to the area conditions of a standard orifice.

Tests of this valve prove the value of this method of regulation, in that all the requirements of practice are afforded by it for all of the high lifts. Any one sufficiently interested can lay out a valve of this type, and he will find that if the characteristics of the spring to be used are known, he can calculate with reasonable accuracy the lifting force at any lift and also an approximate value of the total lift. In calculations of this nature the reduction of pressure on the spring-load area, as previously explained, must be taken into consideration.

Diagrams Showing Performance of Experimental Valves

I have with some difficulty succeeded in getting some diagrams from valves under service conditions which, I believe, show in detail the results of the methods of regulation which are employed. Fig. 11 shows the arrangements of the valves for testing. The tests from which the diagrams were secured were carried on at the power plant connected with the new buildings to be occupied by the Massachusetts Institute of Technology.

One of the regular 4-in. valves was removed and a Y-base substituted in its place; the regular 4-in. was then placed on one of the branches and on the other was placed a special by-passed gate valve and finally, on top of this, the valve on test was connected. Under the above conditions the valve on test was well above 3 ft. higher than the top of the drum. Those experienced in safety-valve action will realize that this height is apt to seriously affect the action of the ordinary valve. The recording apparatus used consisted of a clock motion adapted to turn a chart once in 15 minutes. Bearing on this chart was a pen rigidly connected to the spindle of the valve and adapted to leave a record thereon of lift with respect to time, the lifts being multiplied by a ratio of approximately four to one.

Fig. 12 shows a chart of the performance of a valve with a 2½-in. seat. This

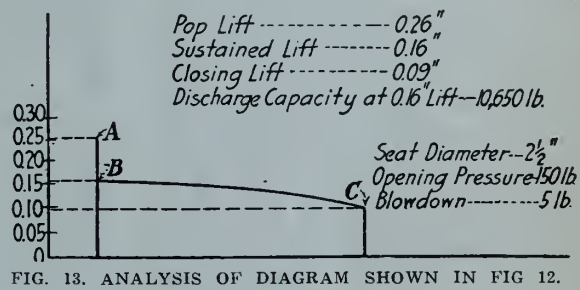


FIG. 13. ANALYSIS OF DIAGRAM SHOWN IN FIG 12.

valve was blown at 150 lbs. gauge boiler pressure and showed, under the existent regulation, 5 lbs. blow-down and almost no warning. In order that it may be clearly understood, it has been transferred to a diagram having rectilinear axes, on which is plotted the scale of lifts which resulted from the calibration of the recording lift gauge with an accurate micrometer. In Fig. 13 the sudden pop lift is shown at A, and the corresponding sustained lift at B. The variations in lift at the point B are further evidence of the readjustments of pressure which determine the pop and sustained lifts, an idea of which may be gained from the theoretical considerations previously stated in this paper. The discharge capacity of this valve was such that the popping pressure was not maintained, and the curve from B to C shows the reduction in lift, which in this type always corresponds to a reduction in boiler pressure. At C the valve closed suddenly, with less than half its initial sustained lift prevailing.

In other words, the drop lift of this valve, which is numerically 0.09 in., is about equal to that of a low-lift valve, while its discharge capacity at popping pressure is nearly twice as great as regards lift, and is even more when seat angle and efficiency are taken into ac-

count. This diagram shows the action of the valve when adjusted to give action somewhat similar to that to be found in some types of valves now procurable, and is in a good many ways ideal. Attention is called to the smoothness of the curve between B and C as evidence of

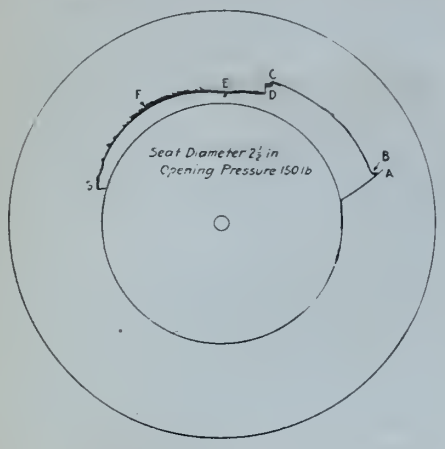


FIG. 14. PERFORMANCE CHART OF VALVE OF FIG. 12 WITH BLOW-DOWN RING LOWERED.

the Equilibrium between lift and boiler pressure existed as the boiler pressure existent as the boiler pressures is reduced.

Fig. 14 shows precisely the same valve with its outside or blow-down ring lowered slightly. This diagram, like the one preceding, is reproduced from a photograph of the actual diagram, and has not been transferred to rectilinear axes because of the difficulty in showing the fluctuations in lift. The section of the curve at A shows the pop and sustained lifts as before. From B to C is shown the gradual reduction of lift corresponding to decreasing boiler pressure, until the point C is reached, where the disk suddenly falls from a reasonably high lift to a much lower one. This action is due to the large initial clearance of the blow-down ring, which throws it out of action entirely when the lift valve at C is reached. The fluctuations in lift at the point C show the lack of equilibrium at this point in the action, which results finally in the drop to the lower lift. At the lower lift, represented by D, all the supporting force is that due to the inner or warning ring.

The downward slope of the curve from D to E shows the tendency of the valve to decrease its lift with decreasing pressure, and closure would doubtless have taken place at D, had not the fans been started at this point in an attempt to force the pressure back to the popping pressure. The section from E to F shows an increase in lift corresponding to the increase in pressure. The fluctuations in lift during this period show a tendency of the blow-down ring to come into action, it being prevented from doing so only by the lack of pressure. The fans were shut off without orders at F, and the valve immediately blew down and closed with 0.04 in. closing lift at G. If we suppose the diagram to have been completed by closure at D, as would have been the case without the high-lift valve with a closing lift less than that obtainable from any low lift valve or ordinary design. That this action can be and is continually repeated by valves of this type is a fact to which every one who has been a witness of the blowing of this valve will testify. To those who have heard such valves blow, no diagrams are necessary.

It was decided after the two preceding diagrams were secured to change to a smaller valve of lower discharge capacity, under which the pressure could be regulated as desired. It is my purpose to bring out by the three diagrams which follow the faculty this type of valve has to respond, under ordinary conditions of regulation, to accumulated pressure. above the opening pressure. The new Boiler Code rules, if put into force, will allow 6 per cent. accumulation of the pressure, and I wish to show by the diagrams what advantage may be taken of this accumulation.

Fig. 15 shows a chart taken from a 2-in. valve in which the pressure was not allowed to accumulate. The low closing lift in comparison to the sustained lift is to be noted. Fig. 16 shows the same valve with an accumulation of pressure over the opening pressure of 4 per cent. This is under the same regulation conditions as the next preceding chart. The substantial increase in lift and corresponding discharge capacity is to be noted, together with the same closing lift.

In Fig. 17, the valve was regulated to give a low sustained lift, and was then given the full 6 per cent. accumulation. It is clear that the lift at B is more than 10 per cent. greater than at A, so that the discharge capacity at 6 per cent. accumulation is more than 100 per cent. greater than that at the opening pressure. The low closing life is to be noted as before. The blow-down on this valve was about 2 lbs., so that this chart was made between a maximum

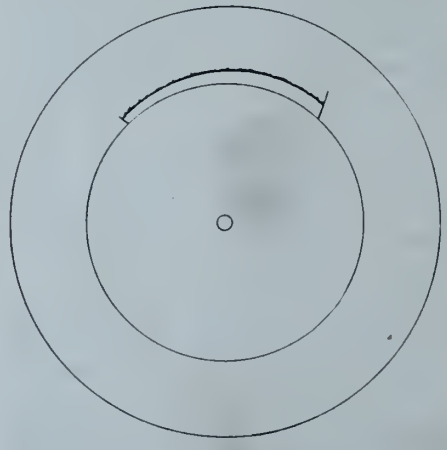


FIG. 15. PERFORMANCE CHART OF 2-INCH VALVE. SUSTAINED LIFT AND LOW CLOSING LIFT.

pressure of 159 lbs., and a minimum pressure of 148 lbs. The New Boiler Code specifications rate valves on their sustained lift at the popping pressure, and so it is clear that with this type the basis is amply safe.

In presenting the diagram shown in Fig. 18 for consideration, I believe I am bringing forward one of a safety valve which is absolutely new, both in conception and results. It has been the aim of safety valve designers to produce a valve which relieves a boiler with an

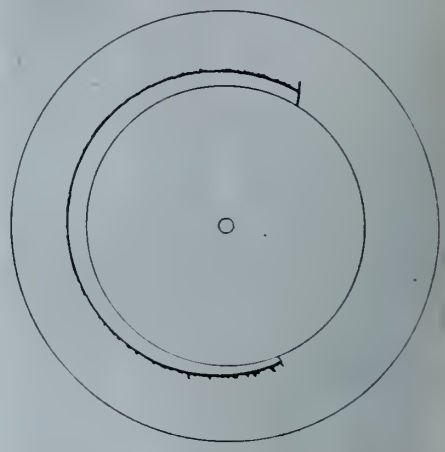


FIG. 16. PERFORMANCE CHART OF 2-INCH VALVE. PRESSURE ACCUMULATION BETWEEN OPENING AND CLOSING.

action that is smooth, while embodying as few sudden flucuations in pressure as is possible. The Boiler Code Committee recognized the exhibition of standard valves to respond to accumulated pressure by incorporating the 6 per cent. accumulation rule. The ideal safety valve for practical purposes is, I believe, one in which a reasonably low life is maintained at the popping pressure, but one which will on the slightest accumulation respond with an extremely high lift to take care of the emergency. If a low lift is available at the popping pressure for ordinary relief, a low blow-down may be incorporated, the condition imposed by absolute safety being that at slightly above the popping pressure the lift will have increased to such an extent that any possible emergency will be taken care of.

Fig. 18 shows a diagram from a valve which produces the above action, and is what may be called a second-opening valve. Many of this type have been built, and it has been found that with the proper regulation of rings, all valves having two rings will produce this action in modified forms. Imagine, first, one of the ordinary type blown with the outside ring removed. This would result in a low lift and a very low blow-down. Now suppose that the blow-down ring is in place, but that it is given such a large initial clearance that the valve will act, provided that it has sufficient capacity to relieve the boiler exactly as before, yet if it has not the required capacity the pressure will accumulate and the increase of lift resulting with only the inner ring in action will finally bring the outer ring into action, and a second pop will occur. This pop will result in a high lift, with corresponding high discharge capacity, and the valve size may be proportioned to give the required safety.

That this action can be accomplished in actual practice is shown by the diagram in Fig. 18, which resulted from the action of a 1¼-in. valve on a boiler,

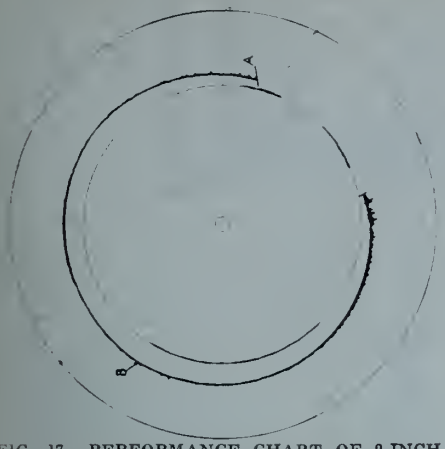


FIG. 17. PERFORMANCE CHART OF 2-INCH VALVE. LOW SUSTAINED LIFT WITH PRESSURE ACCUMULATION.

or rather boilers, of sufficient capacity to produce the required accumulation. The first pop and sustained lifts are shown at A, the sustained lift being very slow. The increase in lift between A and B finally results in the second pop, shown at B, which is the result of accumulated pressure. Between B and C the lift gradually falls as the pressure is reduced, until at C the outside ring goes out of action and the disk drops to a low lift, which is at the given pressure just sustainable by the inner ring. As the pressure is reduced the lift decreases, and after a slight blow-down the valve closes at D with a very low closing lift. This valve had a seat diameter of 1¼ in. and lifted at its highest sustained point about 0.11 in. This lift was the result of about 4 per cent. accumulation, and the calculated discharge capacity is 5,100 lb. per hour, which is approximately 170 boiler h.p.

Features of Design

Careful design will allow of bringing the second pop down very near the first one, and the limits of regulation may be so built into the valve by limiting the possible up and down movement of rings, so that this second pop will always come within a given range of pressure. This type of action has many advantages to recommend it. The absence of sudden excessive changes in relieving capacity and the low lift at closure are evident from the diagram. It is clear that if a boiler had two valves of this type, the second might be set to blow at a pressure corresponding to the point O on the diagram, so that the two valves would be able to handle the boiler at all ordinary times without the second pop, but in the case of emergency both would rise to the second pop lift. The installation would then be essentially a low-lift installation, but woud have all the advantages of high lift in the case of emergency.

Discharge Tests

In the course of the experimental work very few discharge-capacity tests could be run, since most available plants have no means of measuring the water used. Four tests were run at Annapolis, Md., at the United States Naval Experiment Station, which establish the fact that the standard orifice type is nearly 100 per cent. efficient in discharge capacity per unit of lift. The first three tests were made early in the experimental work, the fourth being run at a later date. The reported results of these tests are shown in Table I.

Test No, 2, when compared with the other tests. shows so low an efficiency that it obviously includes some error in the reported data, so it seems fair to assume that the efficiency is very nearly 100 per cent., or, in other words, within the limits of the experimental error in a test of this nature. As a comparison it may be of interest to note that the 3-in. valve assembled for test weighed only 8885 lb.

It is always interesting to compare the results obtained from any piece of apparatus with those which we know to be theoretically possible. In the case of safety valves the full-opening valve serves as a convenient basis of comparison, in that its capacities may be calculated without reference to the type of valve used. If we attach a standard orifice to a boiler we have then the most efficient way of discharging steam, and this on a basis of throat diameter may be characterized as the full-opening valve.

In line 1, Table II., are shown the capacities of full-opening valves of several diameters figured directly from Napier's formula. Line 2 shows the discharge capacity of valves of the same diameters as read from the table in the recent A. Soc. M. E. Boiler Code. I have assumed that these values represent standard conservative practice. Line 3 shows the discharge capacity of the type of valve which I have described, and is the result of calculations involv-

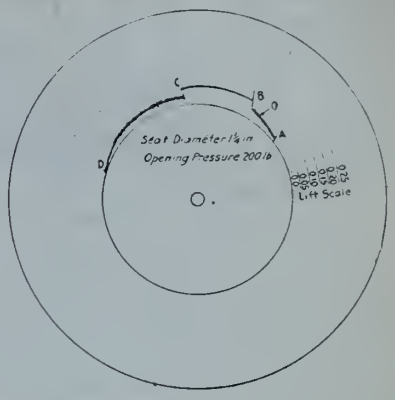


FIG. 18. PERFORMANCE CHART OF A SECOND OPENING VALVE.

ing the sustained lift as measured from the diagrams at the popping pressure.

It seems reasonable to believe that the spring load of a safety valve is to some extent a measure of the shock at closure, which may be expected. Since all valves of the same diameter have approximately the same spring load, some other basis than diameter must be chosen for comparison. Discharge capacity is the first requisite in all valves, and so the spring load has been calculated per 100 lb. of steam discharged per hour. Line 4 shows the spring load per 1,000 lb. discharge of ful-opening valves, which is, of course, constant. Lines 5 and 6 show the same quantity calculated for Am. Soc. M. E. valves and for the proposed type. Lines 7 and 8 show the percentage of full opening attained by the two available types.

There is reason to believe that we shall soon have boilers which will operate at 600 lb. pressure. Consideration of some of the values given in this table is interesting in this connection. A 4-in. valve set at 600 lb. pressure will have a spring load of approximately 7,540 lb., or about 3½ tons. Now if a 2-in. valve can be constructed to give twice the lift of the 4-in., it will have the same discharge capacity, but its spring load will be only one-quarter as great, or 1,885 lb. In other words, the discharge capacity varies as the first power of the diameter and the lift, but the spring load, which is independent of the lift, increases as the square of the diameter. It seems clear from this that high-pressure boilers will of necessity require small-diameter high-lift valves.

TABLE I.—RESULTS OF DISCHARGE TESTS ON VALVES OF THE NEW TYPE.

Test No.	Valve Diameter, In.	Opening Pressure, Lb. per Sq. In., Gage	Blowing Pressure, Lb. per Sq. In., Gage	Percentage Accumulation	Discharge, Lb. per Hour	Efficiency, Per Cent.	Lift, In.
1	2.5	150	158.8	5.86	17,325	99.43	0.252
2	2.5	200	212.9	6.44	16,892	78.88	0.238
3	2.0	200	203.4	1.70	10,176	101.57	0.145
4	3.0	248.5	248.5	0.00	24,482	96.26	0.204

TABLE II.—CALCULATED CAPACITIES OF FULL-OPENING VALVES.

Opening Pressure, 150-lb. Gauge.

Nominal Valve Diameter, In.	2	2½	3	3½	4
1 Discharge capacity of a full-opening valve, lb. per hr..	26,600	41,600	59,900	81,600	106,500
2 Discharge capacity of A.S.M.E. valves (from table), lb. per hr.	2,529	3,613	5,419	6,954	8,670
3 Discharge capacity of proposed type (from tests), per hr.	5,310	10,640	15,400	.....	.....
4 Spring load of (1) per 1000 lb. discharged, lb.	17.7	17.7	17.7	17.7	17.7
5 Same for A.S.M.E., lb.	185	204	196	208	218
6 Same for proposed type, lb.	88.5	69.2	68.9	.....	.....
7 Percentage of full opening attained by proposed type	26.6	25.6	25.7	.....	.....
8 Same for A.S.M.E.	9.51	8.67	9.05	8.50	8.15

Table II. shows the net result of the development in spring-loaded safety valves, and serves to emphasize the opportunities which may be grasped by the designer.

The question of the effect of back pressure in the casing of a safety valve has been much discussed. It has been said that it may operate in two ways to reduce the discharge capacity. First, the effective lifts may be reduced, and, it has been held that back pressure reduces the efficiency of discharge of the orifice. If any of the disk area is exposed to back pressure the lifts will be reduced to some extent, but consideration of the theory of flow through an orifice, and particularly a standard orifice, brings out the fact that as long as the back pressure in the casing is less than 0.6× boiler pressure, the discharge of the orifice is not affected.

The discharge-capacity tests made some years ago by P. G. Darling, mem. Am. Soc. M. E., went some distance in establishing this fact, although no general conclusions were drawn. It remained for a section of a Committee of the American Society of Refrigerating Engineers, with Prof. E. F. Miller, Mem. Am. Soc. M. E., as chairman, to establish this fact beyond question. In refrigeration installations long discharge pipes are required, and the pipe friction produces so much back pressure that either the ordinary type of valve is useless or its discharge pipe must be of an excessive size. Experimental work resulted in a valve which was so constructed as to take advantage of back pressure to increase its lift without in any way having its discharge

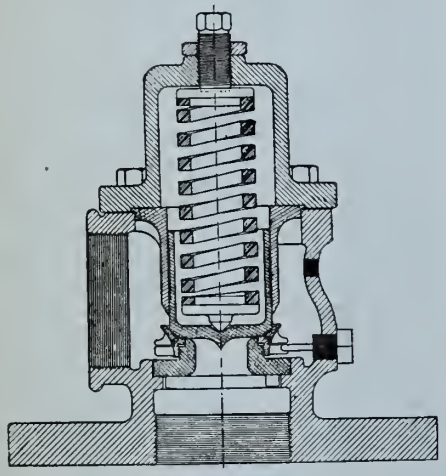


FIG. 19. STEAM SAFETY VALVE OF APPROVED DESIGN.

capacity per unit of lift reduced. That valve was due to the ingenuity of F. L. Fairbanks, Mem. Am. Soc. M. E., of the Quincy Market Cold Storage and Karehouse Co., and has been adopted as the standard in Massachusetts for refrigeration work. The possibility of working with back pressure operates to reduce the discharge pipes to reasonable sizes in spite of their length.

Examples of the New Valves

Fig. 19 shows a complete view of a valve which has the desired advantages. In the first place, valves of high lift, and by that I mean higher lift than any of those obtainable at present, must be guided from above, as guides in the base will cause too great a drop in pressure on the disk area. In this view the disk is made in the shape of a hollow piston, which is guided by a cylin-

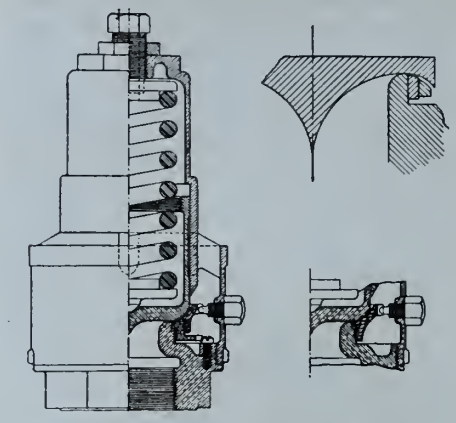


FIG. 20. LOCOMOTIVE VALVE OF APPROVED DESIGN.

drical sleeve that encloses the spring chamber. The fit existing between these is extremely loose, and no attempt is made to prevent leakage by the disk. This loose fit insures that the disk will not bind because of expansion or contraction between the members due to temperature changes, and is long enough in relation to the diameter of disk so that it will never cock. Its looseness alone insures that the disk will come to a uniform bearing on the seat, and it has been found that under no conditions of back pressure has the leakage by it been sufficient to produce pressure in the spring chamber, which is vented. With this type, the back pressure may be built up to nearly 0.6× boiler pressure without hampering the discharge capacity in the least, and since the back pressure is a result of the effective opening of the valve, it has no effect whatever on regulation if it is brought about by the means shown.

In the case of duplex or triplex valves having a common discharge pipe, the opening of one will tend to open the other, due to the exposed area outside the seat and the impossibility of back pressure acting downward on the disk. It must be understood that the commercial types of valves which are shown in the following illustrations are not dependent on back pressure for any part of their action, but are in every case adapted to work with it without harmful effect. Fig. 20 shows a locomotive valve of approved design, and Fig. 21 the proposed marine type of exceedingly large capacity.

Having shown a valve in which there is substantial increase in discharge capacity over those in use at present, and having demonstrated that this may be accomplished with lower closing lifts than are now the rule, attention is called to a possible improvement in this type. It will have been noted by this time that in all the types shown the passage turns upward from the seat region, and it is also clear that so far as the area conditions go it might as well be turned downward, the area conditions will remain constant, as illustrated in Fig. 22, but there will be available as lifting force a factor which would act upward on the disk, and which is commonly known as a jet action. Some few valves of this type have been constructed, and the results gained have been convincing of their possibilities. Enormous lifts have been attained with the same absence of shock at closure as is the case with valves herein described. The problem has been by no means solved, but advances have been made in a direction which tends to indicate that it will be solved finally, and will result in enormous discharge capacities per inch of valve diameter, with the same efficiency per unit of lift. It is clear from a consideration of the diagram that the force due to jet action will not be destroyed by back pressure, as the velocity of the issuing jet of steam is a function of the orifice pressure, which pressure is not affected by the back pressure.

In closing this paper, attention is directed to the fact that this valve is not essentially a high-lift valve. It may be designed to give low lifts as well as high lifts, and is easily adaptable to the proposed Am. Soc. M. E. specifications. It will, of course, under the specifications, benefit by reason of its flat seat and by a discharge capacity about 30 per cent. greater than the 45-deg. seat now in common use.

I have shown that it is possible to produce a valve of high lift as regards discharge capacity and low lift as regards the shock at closure. This one

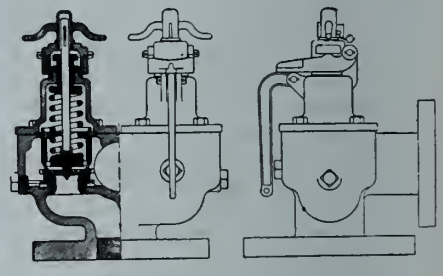


FIG. 21. MARINE VALVE OF APPROVED DESIGN.

feature alone removes the most serious objection to high lift. It is clear that for all of the reasonably high initial lift the valves have a marked faculty to respond to over-pressure. Finally, high-lift valves must come into general use, as the safety requirements in boiler practice must be more economically met than is the case at present. It is distinctly the province of the experienced and unbiased engineer to lay down the rules that will govern future safety-valve installations, but in determining the rules the valves must be considered on a basis of discharge capacity and action rather than lift.

Power Transmission Section

TURBINE GEARING

By D. Street.

IN turbine reduction gears for ship propulsion the width of the gear must of necessity be very great as compared with the pitch and the diameter, and wherever this condition exists the difficulty of maintaining an even working pressure over the whole width of tooth surface is enormously increased. The unavoidable minute irregularities in the cutting of the gear may easily cause the burden of the load to be taken by only a small part of the total width of face at a time; the incidence of the load swaying from side to side of the gear at each rotation; while the torque in the pinion itself, which can never be entirely eliminated, may cause that part of the tooth-face nearest the turbine to take permanently an undue share of the duty. From these circumstances spring the liability of the turbine reduction gears to vibration, noise and unexpected breakage, and the necessity for employing gears of a larger pitch, strength, and weight than would otherwise be necessary.

The problem is, however, by no means insoluble. Macalpine was the first to tackle it seriously. His original arrangement was one in which the pinion was carried in a rocking frame which permitted it to give a little under extra pressure at either side, and so maintain an equality of pressure across the tooth-face. Later hydraulic compensating support was substituted for the mechanical support.

Excellent results have been obtained from this method of automatic self-alignment of the pinion to the wheel, but more recently the problem has been attacked from the other side by building a wheel which will adapt itself to the pinion. The gear is built up of a number of plates machined to a form which gives them the desired degree of lateral flexibility. These plates are put together, engaging solidly at the hub, and also engaging on a narrow edge at the periphery. When so built together, they form a solid cylinder, which can be spirally cut in the ordinary manner. After cutting, the edge engagements are relieved with a small dividing tool, so that each disc is operated independently, and is free to deflect laterally under the side pressure which results from its diagonal engagements with the pinion. The parts are so proportioned that this lateral deflection can at no time involve fibre strains which could possibly cause destructive fatigue. A very small amount of this lateral deflection is sufficient to afford the desired distribution of load, and this amount can easily be given without approaching dangerous periodic strains.

The commercial development of this gear is already well advanced. About 72 sets of the gearing have been applied to turbo-generator drives, and some of these have now been in service one and a half years; about seven sets have been fitted to ships which are now in service, some of them having been long voyages. It is stated that in all of this practical experience no case of trouble with gearing has been developed, and no appreciable deterioration of gears has been observed. Contracts are said to have been closed for machinery for the propulsion of 70 ships, aggregating 215,200 horsepower.

Whether self-equalising devices of one kind or another are really essential to efficiency in turbine gearing depends in some measure upon the degree of accuracy which can be reached in the gear cutting process. While the developments with flexible trunnions and wheels have been going forward, important improvements have been made in the method of cutting large gears, whereby the errors in the master wheels are broken up, and so distributed over the surface of the gear as to be practically eliminated.

VARIABLE SPEED TRANSMISSION DEVICES

By C. T.

IT IS curious to note how after a century or more of intense mechanical development, some of our most widely used machines and mechanical devices are of a type that appears to outrage every mechanical principal. The picking motion of the loom is one of such devices, the combination of motor cycle and side car is another, the sliding gear variable speed device for power driving road vehicles and other machines, is a third.

A study of some of these apparently barbaric survivals leads to the conclusion that their practical advantages outweigh fundamentally their technical deficiencies, and suggests that they are not likely to be superseded by more "correct" devices that will better satisfy the mechanical sense. They may be all wrong, but they give more for a dollar than any alternative arrangement. In most cases they appear to owe their continued existence to the fact that being early established as a standard device, a hundred times more effort has been given to their improvements than to the development of any radically different and, perhaps better method, so that the competition continues to be between an actual much improved and bad thing and a prospective ill-developed good thing.

Whether the sliding change speed gear now employed on the overwhelming majority of road motors belongs to the first or second of these arrangement classes it is as yet too early to say, but the arrangement is too crude to go for a long time unchallenged. Mr. R. E. Phillips in his admirable paper on variable speed gears, read last month before the Institute of Mechanical Engineers, admits that although from an engineer's point of view it is theoretically an embodiment of everything that is wrong, it has been developed to the perfection to which its design has been brought, by the high standard of workmanship employed in its manufacture, and by the use of the highest grade of materials. into a completely satisfactory piece of mechanism. In practice it has proved to be "not so bad as it looks," and it has managed to hold its own for nearly 20 years against many other gears which, theoretically, should give better results. This condition of things he attributes, however, partly to the factor above mentioned, that nothing like the same attention has been devoted to other transmission devices as to this, and partly to the fact that the motors now used are of such a high horse power that at least 75 per cent. of the running is now done on the direct drive.

The amount of effort that has been given to the improvement of the side meshing type of change-speed gear is evidenced by the number of varieties that have been involved. These have been catalogued by M. Rutishauser, an eminent French engineer into no fewer than 9 main divisions and 20 sub-divisions. The most frequent aim of the inventor has been to prevent the undue wear and tear on the teeth of the wheels due to the clash engagement, and the problem has been tackled in many ways.

The side mesher action can, of course, be divided altogether at a price. All that is necessary is to keep the several trains of gears constantly in mesh, and bring into action the particular train required by means of some form of clutch. This method, though theoretically attractive has in practice three weighty drawbacks; it increases the

length and weight of the gear box, it adds greatly to the complexity and cost, and it means that all the wheels are running all the time. A happy compromise is that in which the sliding wheels are mounted loosely on their shafts, and are brought into mesh with the respective corresponding wheels of their trains before they become coupled to the shaft on which they are mounted.

FABRIC BRAKE AND CLUTCH LININGS

By L. E.

THE extent to which fabric has replaced all other substances as a friction material for brake and clutch linings is hardly realized even by engineers. Practically every automobile, for example, now has fabric lining on its clutches and brakes, whilst all the underground railways in London and Paris, as also in the Glasgow subway, now use fabric brake-linings in place of metal blocks. Mr. J. Oswald, of Glasgow, stated that cotton brake-blocks were first tried on horse-cars and were found to have points of very great superiority over wood, especially as regards their efficiency when heated by friction.

Since that time great improvements have been made in the manufacture of friction fabrics. The bonding cement has been rendered more heat proof, and a process has been developed whereby the burning point of the fabric itself is raised 75 per cent.

Fabric lining is of two main kinds—that made of cotton, and that made of asbestos. According to Mr. Oswald, the cotton fabric has the highest co-efficient of friction, i.e., 0.5 to 0.7, and is capable of absorbing much greater work in foot-pounds per sq. in at a given pressure than asbestos material. The co-efficient of friction rises with increased temperature, and is practically unaffected by oil or water. In actual test results obtained by the National Physical Loboratory on cotton material, the work absorbed in foot-pounds per sq. in. per minute was 72,000 dry and 70,000 when lubricated, the pressure being 39 lbs. dry and 160 lbs. lubricated.

The choice between cotton and asbestos is determined in part by the amount of heat that is likely to be generated. The heat limit with cotton is 400 deg. F., and in all cases where this heat limit is likely to be exceeded it is advisable to adopt asbestos material. The co-efficient of friction of this material is 0.3, and it is remarkable that it practically remains constant under varying conditions. Its value lies in its great heat resisting qualities, which recommend its use on exceptionally heavy and prolonged braking or similar duties. Owing to its nature, asbestos material is usually reinforced with brass wire, which makes it more expensive than cotton. Failures with fabric linings are not unknown, but the majority of them Mr. Oswald ascribes to preventable causes: (a) The use of wrong material; (b) to failing to keep the fabric face clear of the opposing face when the brakes are out of action; (c) failing to ensure that the fabric is kept well home when applied, or, in other words, "followed up"; (d) incorrect fixing of linings to the engaging media; also (e) through expecting too much from brakes which have been under-dimensioned by the makers for the duties they have to perform.

Collieries, it appears, are now taking up fabric linings extensively for brakes on main winding engines and haulage gears. Their use saves the rope considerably on account of the smoother action, the upkeep cost is even less than with wood, and there are further advantages in the shape of improved control and speedier working.

The immediate reason for introducing fabric linings for the brakes of the underground railways is interesting. Iron brake blocks give off an amount of iron dust which totals to surprising figures. Three-quarters of a ton of brake-dust per mile has been proved to be produced every month in the New York subway. This dust not only short-circuits the electrical signalling apparatus, and causes stoppage of trains daily, but as it settles on the track the oil from the motors becomes mixed with it and forms a highly inflammable mixture. It was the accumulation of this and the red-hot sparks from the metal blocks which caused the Paris fire a few years ago, in which 480 people lost their lives.

It was partly to prevent these troubles that the cast-iron blocks were abandoned in favor of cotton linings. Since their introduction not a single fire has been reported on any of these railways. Continued use led to the discovery that there was no appreciable wear on the tyres and rails, these being highly burnished. A further very important result is that since fabric linings have been used, rail corrugation and flats on wheels, which commonly existed with the use of metal brake blocks, have disappeared.

BALL BEARINGS

UNDER the auspices of the Society of Engineers (Incorp.) a paper on Ball Bearings was read on April 2 by A. Marshall Arter, F. S. E. A brief resume was given of Prof. Stribeck's investigations.

Before these investigations were made little was known beyond Henry Hertz's theoretical deductions on the contact of elastic bodies. Prof. Stribeck measured the approach of hardened steel balls under compression and found that the admissible static loads varied as the square of the diameter; he also found that ball bearings in which the load is carried at right angles to the axis of rotation of the balls were alone suitable for heavy loads. It was pointed out that the balls in modern ball bearings did not burst, but that the surface flaked out when overloaded, the load-carrying capacity depending upon the elastic limit of the surface of the steel.

The author further pointed out that the ball bearing of to-day could never have been made a commercial success but for the very high degree of accuracy in its manufacture. If a load of 130 lbs. is put upon a ball half an inch in diameter, it is compressed one-thousandth of an inch, and hence if one of the balls in a thrust bearing is one thousandth of an inch larger than the rest, or there is a high place in the race of this amount failure is certain if the normal load of the ball is at all approaching the safe working limit.

The relation of load to speed was dealt with, and it was shown that the safe working load of a ball was reduced on increasing its speed of rotation, in thrust bearings the amount being greater than in radial ones. Prof. Goodman's method of examining balls under a microscope for detecting overloading was explained.

The gyroscopic effects, at high speeds, in thrust bearings was next dealt with. It was shown that there is a certain minimum load necessary to prevent the balls skidding, due to gyroscopic torque, and that there is an absolute limit of speed at which a thrust bearing can be run, namely, when the maximum and minimum loads coincide.

POWDERED COAL AS FUEL

THE condition in which powdered coal must be furnished to produce satisfactory results has been developed to a point where it can be considered as definitely standardized. Not only for the sake of combustion efficiency, but for the sake of more perfect pulverization, the coal should be practically dry, 1 per cent. of moisture being the maximum amount at which pulverizing can properly be effected. One-half of 1 per cent. moisture is the figure which is ordinarily required. Under these conditions the coal when pulverized remains quite fluid, and will break down under the influence of the crushing rolls with much less expenditure of power than when damp.

In order that the fuel may remain suspended in the carrying air and in the furnace chamber during combustion, it is necessary to reduce it to a certain degree of fineness. After a great deal of experimenting this standard has been established as follows: 85 per cent. must pass through a 200-mesh screen and 95 per cent. must pass through a 100-mesh screen.

Much has been printed regarding the quality of coal most suitable for pulverization, but no arbitrary limits can be established as to the proximate analysis most suitable. Broadly speaking, the greater the volatile combustible content the more readily will the coal ignite and burn, and the less dependent will be this process upon the size and proportions of the combustion chamber. As the volatile content decreases, however, more dependence must be placed upon the proportions and location of the surrounding brickwork, in order to maintain the temperature until ignition is complete. Anthracite coal has been burned in a pulverized form, but it must be very finely ground and must be burned in a rather confined space so that the ignition may be prompt and aid be rendered by nearby brickwork during the early stages of combustion.

Steam and Its Generation

WHERE COMBUSTION TAKES PLACE

COMBUSTION of coal takes place partly in the fuel bed and partly in the space above the fuel bed which is commonly called the combustion space. The process of combustion in the fuel bed consists chiefly of the gasification of the fuel. The products of this gasification are mainly CO_2, CO, CH_4, and H_2. The combustible gases rising from the fuel bed are burned in the combustion space by uniting with the oxygen in th eair admitted through the firing door or other openings specially provided for the purpose, and the combustion is complete if the supply of air and the size of the combustion space are sufficient.

Amount of Air Needed

To burn completely 1 pound of coal in a boiler furnace requires about 3 pounds of oxygen or 15 pounds of air. One pound of coal will make a solid cube with 2¾-inch edges. Fifteen pounds of air at atmospheric pressure and temperature occupies a volume of about 200 cubic feet, which is approximately the volume of a 6-foot cube. The volumes of these two cubes show the relative volumes of coal and air that must be fed into the furnace to obtain complete combustion.

How Air Should Be Supplied

In the combustion of coal both the amount of air and the way in which the air is supplied are important. The air may be introduced to the coal at an average distance of several feet or of a small fraction of an inch, the time required for combustion in either case depending on this average distance through which the oxygen has to pass in order to come in contact with the surfaces of the coal.

Thus, for exampple, if a 2¾-inch cube of coal were placed in the center of a 6-foot cubic container filled with air and kept hot, it would burn completely. However, combustion would be slow and might require several hours, although there would be enough air in the container to burn all the coal. The combustion would be slow because the oxygen is suppplied at an average distance of more than 2 feet from the surfaces of the small cube of coal, so that most of the oxygen would have to pass this average distance of 2 feet by the slow process of diffusion, and the products of combustion, chiefly CO_2, would have to be moved away a like average distance by the same slow process.

If, however, the 200 cubic feet of air required to burn the cube of coal were passed at high velocity in thin streams one-sixteenth inch thick over the surfaces of the cube of burning coal, combustion would be rapid, because the oxygen in these streams of air would have to move an average distance of only one thirty-second of an inch to get in contact with the coal. Furthermore ,the oxygen would be greatly aided in passing through this average distance of one thirty-second inch by the eddy currents formed by the high velocity of the stream of air, and would not depend on the slow process of natural diffusion.

Therefore, for rapid combustion, the air must be supplied in thin streams of high velocity over the surfaces of the coal. In general it may be stated that the rate of burning depends entirely on on the rate at which oxygen is brought into contact with the coal.

Features in Furnace Design

The devising of the best method of bringing the oxygen and the coal together, or, in other words, the feeding of coal and air into the furnace, is the dominant feature in the problem of furnace design. As coal must be heated to its ignition temperature before it can be made to burn, another important feature is the method and the rate of heating the coal. There are other important features in furnace design, but the two mentioned are the most important.

BOILER TROUBLES DUE TO FOAMING OR PRIMING

BOILER troubles due to foaming or priming apparently depend to a large extent upon the concentration of alkali salts in the water within the boiler, although silt, organic matter, loosened scale, lubricating oil, character of load and design of boiler all have an appreciable bearing upon this phenomenon. Surface blowing is of course a remedy where it can be applied, and in the majority of cases the proper use of the main blow-off will remedy the trouble by reducing the concentration of salts in the boiler. Many waters, not naturally foamy as they come from their source, can be made so by concentration—by driving off a portion of the actual water and leaving the foaming constituents in greater strength in the boiler; this is the reason why blowing off relieves the foaming, because it takes out of the boiler a portion of the concentrated foaming constituents, and the resulting pumping in of fresh water, to take the place of that blown off, dilutes what is left in the boiler to a point where it will not foam. There are many natural waters of sufficient alkali content to produce immediate foaming whenever the pressure at the surface of the water in the boiler is relieved by the sudden and large use of steam. As there is no chemical treatment that will precipitate alkalies from solution, such waters are to be rejected for boiler use.

BLOWING OFF BOILERS

THE main factors in ordinary boiler-water purification are heat, soda ash, and blowing off, with possible filtration when this can be arranged, as is sometimes done with the hot-process system. The blowing-off process is important beyond the average regard in which it is held. It should be done under low pressure if it is to be fully effective in carrying out the sludge, and blowing under low pressure will reduce the boiler stresses that unquestionably are coincident with rapid blowing under high pressure. If blowing off must be done under high pressure, the blow-off valve should only be "cracked," as a rapid blowing with full valve opening will carry out only a small part of the sediment, because the water vortex or "whirlpool" formed draws clear water down through the sludge to the blow-off opening, thus leaving the main body of the sludge intact.

Undoubtedly some of the troubles recorded as due to scaleforming water are really attributable to the disregard of proper methods of blowing off, and to the pumping in cold water, thereby overstraining the boiler material. Some time after a certain boiler had been cleaned with the soda-ash treatment, the tubes at the rear end began to leak, and the question was asked whether it was the soda ash that was causing the leaky tubes. At first it appeared possible that the cleaning had been too well done, but it later developed that, during the day, hot water from a heater was fed to the boiler, while at night cold water was pumped into it, the plant being one where the engine was operated during the daytime only, while the boiler was in service during the full twenty-four hours. The recommendation was made that an inspirator be used to feed the boiler at night, instead of the steam pump delivering cold water, and the leaky-tube troubles immediately ceased after that was done.

ADVANTAGES AND DISADVANTAGES OF POWDERED FUEL

AS is the case with all new things, the early history of the use of powdered coal is replete with accounts of failures, and this has left an impression on the minds of the engineering public which it will take years of successful application to eradicate. The early experimenters did not understand the necessity of fine grinding, and it would seem that they did not appreciate the influence of furnace design upon the temperature of the resulting gases. The coal was powdered sufficiently fine, however, to develop intense temperatures, even though part of the coal was lost by falling to the bottom of the furnace and being thus removed with the slag and ash.

Insufficient combustion space and the ease with which this fuel can be mixed with the minimum amount of air, combined to produce abnormal temperatures and a direct contact of flame and brickwork. The blowpipe effect of the high-velocity jet acted to melt out the brickwork upon which it impinged. A layer of melted lava, formed by the fusing of both ash and brickwork, accumulated in the bottom of the combustion chamber, and naturally discouraged those who depended upon this fuel for continuous service.

Later on, difficulty was encountered due to the minute particles of liquid slag being carried in suspension and deposited upon the tube sheet or water tubes of the boiler, thereby closing up the flame space and putting the boiler out of action. These effects are particularly observable with certain grades of coal, but noticeably absent with others; and only until recently has research work been carried to a point where any knowledge has been obtained of what causes this trouble and what coals are most suitable for firing in powdered form.

Advantages

Having stated the objections, it is interesting to pay equal attention to the advantages of this fuel. From the view point of the theorist, the use of powdered coal forms one of the best methods ever proposed for the promotion of combustion efficiency and commercial economies. In all transformations of energy there is unavoidable loss, and we are not possessed of apparatus which will gasify coal with 100 per cent. efficiency. In the producer there is a succession of losses which reduce the available heat in the gas to a considerable extent, and in the mechanical stoker there are unavoidable losses due to various forms of incomplete combustion. Only in the case of powdered coal is the actual solid fuel both gasified and completely consumed directly within the chamber desired to be heated. With perfect pulverization the entire mass is burned in suspension, and in actual practice but a small fraction of one per cent. is actually lost in the flue dust or slag pan.

On account of the fuel being conveyed into the furnace by the very air which is afterwards to be used in its combustion, and on account of the diffusing of the coal throughout the air in a cloudlike formation, there is a possibility of a mixture which can be secured by no other means. Each particle of coal is surrounded by a particle of air, and on account of the extreme fineness of the particles practically instantaneous oxidation occurs. The result is efficient combustion, and we have to deal only with the effects of the high temperature thereby obtained. That it is now possible to control this temperature while not sacrificing any material gain due to it, is definitely established. Moreover, the definite control of the amount of air per unit permits of the most perfect variation in the results obtained. It would be impossible herein to enumerate in detail all of the means employed to take advantage of an inherent efficiency of this form of firing.

REDUCING FRICTION BY AUTOMATIC LUBRICATION

By J. W. Peterson

THE only economical method of lubricating bearings consists in supplying as much oil as the bearings will take and of collecting, filtering, and using it over and over again. In passing through the bearings the oil takes up small pieces of metal removed from the bearings by friction, dust, etc., also water from condensed steam, which has leaked past the stuffing boxes. If solid matter and water are properly removed from the oil, it is in a condition to be used over again; therefore the crux of a good automatic system of lubrication is the filter, wherein the oil is restored to its original pure and clean state. An engine or machine equipped with an efficient system of continuous lubrication feeding a stream of oil to all bearing surfaces will run much cooler, wear longer and render the necessity of keying up less frequent than is the case where lubrication is provided by oil cups feeding drop by drop.

In the power plant of a shoe factory the engine-room log shows that before the adoption of continuous stream lubrication it was necessary to key up the pins about once every two weeks, whereas since the oiling system was installed, keying up is only necessary every six to eight weeks. One of the engines in this plant, a 200-h.p. Corliss engine, is equipped with an individual oiling and filtering system, and the make-up oil only amounts to two gallons per month. A further illustration of what can be accomplished with a properly designed automatic system of bearing lubrication is furnished by one of the largest public-service plants in the country, where 30,000,000 kw. are generated each month. The total amount of oil consumed for all the main generating units and their auxiliaries amounts to only 300 gal. per month; and in another plant the actual cost of cylinder and bearing lubrication amounts to only two cents per 1000 kw-hr.

Plant Efficiency

The work done by a steam engine is necessarily divided into three parts; that done against the outside load, which alone is the useful work; that done against the back pressure in the cylinders; and that done against other resistances, the most important of which is friction. Work is also done at the beginning of each stroke in overcoming the inertia of the moving parts, but in a properly designed engine most of this should be restored to the engine before the end of each stroke. In the modern type of engines the mechanical efficiency is very high. In tests of ten new engines of different makes—four simple, four compound, one triple expansion and one quadruple expansion—the mechanical efficiency ran from 93 per cent. to 97 per cent.

In engines not so modern in design and which have been running for some time, the mechanical efficiency may be surprisingly low. In one of fifteen engines tested of this class, which have been operating from ten to twenty years, the mechanical efficiency averaged about 70 per cent. In one case it ran as low as 60 per cent. If the mechanical efficiency is 70 per cent., the recoverable loss would be at least 20 per cent. Take a plant of, say 1000 h.p. The cost of producing a horsepower per year is about $30. A loss of 20 per cent. would be 200 h.p. at $30 per year, or $6,000.

The values for the mechanical efficiencies of steam engines are about as follows: 95 to 98 per cent., rare and unusually high; 90 to 95 per cent., usual good practice; below 80 per cent., decidedly low. Experiments on distribution of friction show that the greatest loss, amounting to one-third or one-half of the total friction, occurs in the main bearings; the next important loss is that of the piston and piston rod, amounting to about 21 per cent. of the total friction. Of this amount 6½ per cent. is chargeable to the friction of the piston and rings against the cylinder walls, and about 14 per cent. to the stuffing box of the piston rod, leaving 1.7 per cent. chargeable to unaccountable losses. The losses due to friction of the working parts of an engine include considerably more than the mere loss of power, namely, the depreciation resulting from wear of bearings, guides, and other rubbing surfaces, and the expense arising from accidents traceable to excessive friction.

Designing Lubrication Systems

There has always been a great deal of guesswork, mystery, and secrecy on the part of manufacturers in regard to the general design and installation of automatic bearing-lubrication systems for power-plant machinery. The lack of general information on this subject has resulted in the installation of many unreliable oiling systems not really suited to conditions existing. The require-

ments of an efficient lubricating system are:

1.—A stream of clean oil supplied continuously at just the points where needed.

2.—A filter which will thoroughly remove all dirt, small particles of metal, and entrained water, and properly cool the oil.

3.—The system should be automatic in its operation and absolutely reliable.

One sometimes hears the statement made that oil becomes worn out through use. This is not the case, as has been amply proved by extensive tests made by several eminent authorities. There may be some slight increase in its specific gravity after it has been used continually, owing to the fact that by increase of temperature some of the more volatile oils are driven off and small amounts of cylinder oil used for lubricating the piston rods, etc., become mixed with the bearing oil; however, the heavier oil is still as good as ever, if properly treated. In some cases the mixture of cylinder oil with the bearing oil, which gets into the system from the piston-rod lubrication, causes serious complications on account of the small percentage of animal fat necessary in the cylinder oil. This in time causes the oil to become emulsified and entirely unsuitable for circulating. To remedy this trouble, there are two alternatives: the first is to dam off the space below the piston-rod stuffing box between the cylinder and the guide barrel so that the cylinder oil dropping from the rod is carried off through the bonnet drips and does not become mixed with the bearing oil; the second is to install a wiping device on the piston rod and lubricate it with bearing oil. I know that a great many engineers believe that only cylinder oil is suitable for lubricating piston-rod stuffing boxes, but we have had very good success in several instances by applying regular bearing oil in this manner.

The lubrication engineer has three alternatives to work upon in the design of a scientific system; he may install a central oiling system in which the main supply of oil is stored at one point and conveyed to the bearings of the various power units and auxiliaries by means of main feed and branch pipes to each machine; or he may make each individual engine, pump, air compressor, etc., a unit by itself, and supply it with its own oiling and filtering system; or he may provide a combination of the two by providing one lubricating system to take care of a group of machines.

In the application of the first system it is necessary to install a large part of the apparatus in duplicate in order absolutely to insure continued operation of the plant. The amount of duplication depends a good deal upon the arrangement of the plant, the susceptibility of the various parts to injury, the value of continued operation and also the ideas of the designing engineer. To insure absolutely reliable lubrication, many plants are now installing individual oiling and filtering systems, so that each unit from the smallest auxiliaries to the largest power unit is equipped entirely independently of all other units in the plant. Practically everything necessary for these individual oiling systems is above the engine-room floor and therefore always in sight and under the care of the engineer or attendant.

Splash System

The so-called splash system used on several makes of high-speed engines has many disadvantages. Usually the engine frame forms an oil reservoir, and the crank dipping into the oil at every revolution throws it out on the rubbing surfaces. It soon becomes saturated with small particles of metal and is entirely unsuited for use over and over again between the rubbing surfaces; furthermore, the oil, being at the high temperature of the engine frame, has practically no ability to carry off heat which may be generated in the bearings, and finally on some engines the steam leaking past the piston-rod packing and condensing in the oil reservoir soon mixes with the oil to such an extent that an emulsion is formed, which has practically no lubricating value. The proper lubrication of engines equipped with the splash system can be easily accomplished by connecting an oil supply line into the reservoir of the splash system and a dirty-oil overflow arranged so that a predetermined level of oil is maintained in the reservoir; thus the dirty oil passes out through the overflow at the same rate at which clean oil is delivered into the reservoir. In this way continuous circulation of oil is maintained and good reliable lubrication is insured. Real bearing-lubrication economy is possible only when:

1.—Every bearing is continually supplied with a stream of clean oil so that the rubbing surfaces float past each other on a film of oil instead of coming into metallic contact, reducing cost of producing power.

2.—When the oil is automatically collected, filtered, purified for use over and over again, reducing cost of attendance and oil.

The foreoing are from papers read before the American Society of Mechanical Engineers.

SAFETY RULES FOR SMALL REFRIGERATING MACHINES

THE city of New York regulations for refrigeration plant installations, whose capacity is under three tons are as undernoted, and in view of the fact that not a few such are to be found throughout the Dominion of Canada, the detail possesses a considerable degree of interest:—

In plants of less than three tons refrigerating capacity using ammonia as a refrigerant, the regulations applying to plants of three tons or greater capacity shall be observed, with the exception that the emergency device discharging to the sewer as shown on the Fire Department drawing (A) is eliminated. Instead of the emergency device, an automatic safety valve set to discharge at not greater than 300 pounds pressure per square inch, shall be located on the high and on the low pressure sides at each point of connection as indicated for the emergency lines. The discharge from such automatic safety valves shall be conducted by continuous piping to the open air, or into a tank of water of capacity to absorb the discharged gas.

Where the discharge is to the open air, the outlet of the pipe shall be turned upwards, and equipped with a suitable diffuser, designed to mix the gas with the air without restricting its flow. The location of the diffuser shall be not less than six feet from any wall in which there is an opening, or at a point ten feet above the roof as remote as practicable from horizontal openings in surrounding buildings, provided more than 30 pounds of ammonia is in the system. If less than 30 pounds of ammonia is in the system the distance of six feet may be reduced proportionately to amount of ammonia in the system.

Where the discharge is into a tank of water, the capacity of such tank shall be based upon the maximum quantity of ammonia in the plant. The capacity of the tank shall be such, that for each 30 pounds of ammonia or fraction thereof there shall be at least 30 gallons of water in the tank at all times. If less than 30 pounds is in the system, then the capacity of the tank may be reduced proportionately to the amount of ammonia in the system. The tank shall be substantially constructed with a hinged cover, or, if it is of an enclosed type, it shall have an inlet and a vent hole at the top. No horizontal dimension of the tank shall be greater than one-half a vertical dimension, and the discharge pipe or pipes from the automatic valves shall be attached so as to discharge at the centre of the bottom and there shall be a valve so situated as to drain the tank of water. The tank shall be as firmly braced, hung, or supported as any other part of system, and be kept filled with fresh water, not used for any other purpose. If there are no valves in the system between the compressor discharge side and the compressor suction side other than the expansion valve, then one automatic safety valve will be sufficient, if located on the high pressure side.

All plants using less than 100 pounds of ammonia in the system will be considered as plants of less than three tons refrigerating capacity. Plants using carbon dioxide as a refrigerant shall be equipped with automatic safety valves as outlined for ammonia plants, but the discharge may be to the outer air or into the room in which the plant is located. Such automatic safety valves shall discharge at not greater than 1,400 pounds per square inch.

Plants using ethyl chloride or sulphur dioxide as a refrigerant, shall be equipped with automatic safety valves as specified for ammonia plants and may discharge into the room in which the plant is located, but ethyl chloride plants using more than eight pounds of ethyl chloride in the system shall discharge to the open air. Such automatic safety valves shall discharge at a pressure not greater than 100 pounds per square inch.

Electricity and Hydraulics

STEEL MILL AND CENTRAL STATION

By K. A. Pauly.

A FACT, not generally appreciated, says K. A. Pauly in the *General Electric Review*, is that the power requirements of the large and even the moderate mills exceed those of any other industrial field of motor application. For example, the main rolls of the rail mill at Gary are driven by six induction motors having a combined rated capacity of 24,000 h.p., with a maximum momentary capacity of approximately 80,000 h.p., and the main rolls of the billet mill at the same works are driven by five motors with a combined capacity of 22,000 h.p. with a corresponding maximum momentary capacity. Then, too, we have the large reversing mills which are driven by motors from 2,000 h.p. to 7,000 h.p. taking peaks from 6,000 to 20,000 h.p. momentarily. In addition to the power taken by the main rolls there are a very large number of smaller motors scattered about the plant for driving all manner of auxiliaries required for unloading the ore and transferring it to the blast furnaces, driving the blast furnace auxiliaries, and for transferring the iron and steel from the time it is drawn from the furnace until it is shipped as finished shapes.

The station load diagram of a steel plant is the result of a combination of load curves of almost every conceivable shape ranging from the extremely intermittent cycles of the large motors driving single stands of rolls and the small motors operating the screw downs, lifting tables, etc., to the more or less constant loads of the larger motors driving multi-stand mills, blast furnace pumps, gas washers, etc. The load factor of a central station supplying a steel mill obviously varies with the magnitude of the plant, although that for small plants is higher than might at first be expected owing to the fact that most small works do most of their rolling in multi-stand mills, roll smaller sections, and take more passes to produce a given reduction. Further, the steel is of such length that it is looped in rolling and passes simultaneously through several stands of rolls, and in many mills several pieces are rolled at the same time, thus producing a much more uniform load than obtains with the large single stand mill.

When power is purchased at a rate which is dependent upon the peak demand as well as the energy consumed or where power is supplied from a comparatively small central station means can frequently be provided for reducing the fluctuations in the load, but as the method of accomplishing this result depends upon a variety of local conditions the various methods will not be discussed here.

Group Relation to Central Station

From the standpoint of the central station, steel mills can conveniently be divided into two groups. In the first are included those companies which operate their own blast furnaces, and in the second group those which purchase their steel in the form of ingots, billets, or slabs, etc., for rolling and fabricating works which purchase the rolled shapes. Although a few of those included in the first group do at present and probably will continue to purchase power to supplement that which is developed locally, the large majority of these companies have made and will continue to make all their own power as a by-product, and many have a surplus to sell. The following figures taken from a paper read before the A.I.E.E. in 1909 will serve to indicate the immense amount of energy available as a by-product incident to the manufacture of steel.

As a result of the reduction of the iron ore in the blast furnace there is produced in the form of so-called waste gases approximately 150,000 cu. ft. of gas having an average thermal value of approximately 90 B.t.u. per cu. ft. Of this approximately 30 per cent. is required for heating the hot blast stoves and approximately 25 per cent. for driving the blast furnace blowing engines, gas washing machinery and auxiliaries used in connection with the blast furnaces and blowing engines, leaving 45 per cent. or approximately 320 kw-hr. per ton of pig iron produced available for general power purposes. Also, many of the large steel plants are manufacturing the coke used in the blast furnaces which reduce the ore at the works and have available as a by-product of the coke ovens approximately 10,000 cu. ft. of gas having approximately 500 B.t.u. per cu. ft., of which approximately 50 per cent. or approximately 130 kw-hr. per ton of coke produced is available for general power purposes elsewhere in the mill. As very nearly a ton of coke is required to produce a ton of pig iron in the blast furnace, the by-product power available for general purposes from the blast furnace and coke oven gases is obviously approximately 450 kw-hr. per ton of pig iron. Also in many steel plants considerable additional power is being obtained from waste heat boilers used in connection with the open-hearth furnaces. While the power from this source is small compared with that from the blast furnace and coke oven gases, it is very considerable when compared with many industrial plants, and has an appreciable effect in lowering the cost of producing power in the large modern steel works.

Type of Equipment Installed

There seems to be a feeling inbred into the minds of steel mill men that 60-cycle equipment is not at all suited to steel mill conditions. The foundation for this is doubtless to be found in the fact that all or practically all of the large steel works throughout the country have adopted 25-cycle as the frequency of their power systems. This prejudice is frequently a serious handicap to the public service power solicitor who is trying to interest the steel company in his goods which he can offer only at 60 cycles. Many of the constant speed auxiliaries about the mill are driven by induction motors and with 60 cycles more speeds are available than with 25 cycles, there being seven speeds from which to choose within the range of 500-r.p.m. and above with the former frequency and only three with the latter. Also most of the equipment, such as motor generators, transformers, etc., are cheaper for 60 cycles and equally efficient and reliable. 25 cycles, however, has considerable advantage over 60 cycles for supplying the slow speed, direct connected, main roll motors, the power factor of such motors usually being higher for the same overload capacities and their costs less.

The difficulty of operating gas engine-driven generators at 60 cycles has also been an important factor in bringing about the adoption of 25 cycles by the large steel plants. There is, however, no fundamental reason why motors cannot be designed for 60 cycles to meet the severe rolling mill requirements, and any one of the large electrical manufacturers will readily guarantee such motors to develop the necessary overloads and to operate within any specified heating limits. The power-factor of the slow speed, 60-cycle machines is as previously stated lower than for 25-cycle units, but this defect can be neutralized by synchronous condensers. It is a fact, however, that most of the mills in the plants which fall in the second group are of the size and type which it is customary to drive either through gearing or rope transmission, thus permitting the use of motors of moderate speeds for which 60 cycles is at

least as satisfactory, if not slightly preferable; so that in general it may be said that 25 cycles possesses little, if any, advantage over 60 cycles as a steel mill frequency for those plants which will consider purchasing their power.

Conclusions Drawn

As in the general treatment of all similar problems no definite recommendations can be made which will conform to all the special conditions which may surround any particular case. However, in summing up, the writer feels safe in drawing the following conclusions from his experience in this field of application of electric power. First, that if for reasons other than the question of frequency, the power for supplying the plant is to be developed locally, 25 cycles should be chosen as the operating frequency, except possibly in the case of some small plants referred to below. Second, that for plants falling in the second group, if reliable power can be purchased at a reasonable rate, which the writer believes is always the case, the mill frequency should be that of the available source of supply whether 25 or 60 cycles and the necessary power purchased, unless for reasons other than those having a direct bearing on the power problem, it is considered expedient to generate rather than purchase power. It is conceivable that it might be to the interest of the steel company to operate its own plant, although from power considerations alone this would seem unwise, and in such cases the adopted frequency should in general be the same as that of the local public service company so that in the event of a breakdown assistance can be obtained from the local company.

DIESEL ENGINES v. STEAM TURBINES

A COMPARISON of the cost of generating power by means of Diesel engines and steam turbines, together with a discussion of the different factors governing the profitable use of either type, is given in a paper read by Herbert Haas at the Arizona meeting of the American Institute of Mining Engineers. The author says that in places where neither cheap coal nor water power is available, and the price of oil fuel is increased by cost of carriage, the Diesel engine will become a prime mover of increasing importance. Where water is scarce the Diesel engine also shows to advantage, because about twelve times as much water will be required for condensing purposes with steam turbines under general conditions as is needed for jacket cooling of the two-stroke engine, while engines of the four-stroke pattern require only one-twentieth of the water. The following table of costs of generating power with four 2,000-kilowatt Sulzer-Diesel engines, direct-connected with alternators and exciters, is based on a fuel cost of $1.25 per barrel of 320 lb., and lubricating oil cost of 35 cents per gallon:—

TABLE I.—COST OF GENERATING POWER WITH FOUR 2,000-KILOWATT SULZER-DIESEL ENGINES DIRECT CONNECTED TO GENERATORS AND EXCITERS.

	Full load 12,000 h.p. 8,000 kw.	¾ load 9,000 h.p. 6,000 kw.	½ load 6,000 h.p. 4,000 kw.	¼ load 3,000 h.p. 2,000 kw.
Kw. hr. per year	70,000,000	52,500,000	35,000,000	17,500,000
Barrels	140,000	105,000	70,000	35,000
	Cost per year	Cost per year	Cost per year	Cost per year
Fuel cost	£35,000	£26,200	£17,500	£ 8,750
Labor	3,780	3,780	3,780	3,780
Lubrication	6,130	4,599	3,066	1,533
Maintenance	1,440	1,440	1,440	1,440
Total direct	£46,350	£36,019	£25,786	£15,503
Interest and amortisation	17,280	17,280	17,280	17,280
Total cost	£63,630	£53,299	£43,066	£33,783
Cost per kw. year	7.9	6.6	5.4	4.2

The kilowatt-year is equivalent to 8,760 kilowatt hours. Three units work continuously, and one acts as a stand-by and the cooling water in circulation for 9,000 horse-power, working continuously, amounts to 8,000 to 11,000 cubic feet per hour with re-cooling arrangements.

In table II. the costs of operation under similar conditions, with power generated by two 6,000-kilowatt turbines, are shown. The turbines work with steam at 180 lb. pressure per square inch, steam temperature 620 deg. Fah., inlet temperature of condensing water 60 deg. discharge temperature 75 deg. Fah., quantity of cooling water per 6,000 kilowatt-unit, 74,000 cubic feet per hour. One generating set works continuously at full load and the other is a stand-by:—

TABLE II.—COST OF GENERATING POWER WITH TWO 6,000-KILOWATT STEAM TURBINES.

	Full load 8,000 kw.	¾ load 6,000 kw.	½ load 4,000 kw.	¼ load 2,000 kw.
Kw. hr. per year	70,000,000	52,500,000	35,000,000	17,500,000
Barrels	300,000	210,000	150,000	83,700
	Cost per year per kw. hr.	Cost per year per kw. hr.	Cost per year per kw. hr.	Cost per year per kw. hr.
Fuel cost	£75,000	£52,400	£37,400	£20,925
Labor, etc.	5,000	5,000	5,000	5,000
Maintenance	1,440	1,440	1,440	1,440
Total direct	£81,440	£58,840	£43,840	£27,365
Interest and amortisation	17,280	17,280	17,280	17,280
Total cost	£98,720	£76,120	£61,120	£44,645
Cost per kw. year	12.2	12.6	15.2	22.3

The selection of two 6,000-kilowatt rather than three 3,000-kilowatt steam turbines is made on account of the greater efficiency of the 6,000-kilowatt sets, while the selection of four 2,000-kilowatt Diesel engine units is justified by the author on the ground that larger engines are not any more efficient in fuel economy, and the relative much higher cost of this prime mover makes it a good policy to reduce reserve capacity to a safe minimum.

Prime Mover Selection Considerations

The author concludes that in general the selection of either type of prime mover will be governed by the following economic considerations:—

1—Fuel is of chief influence on the total power cost, where both the B.t.u. price and load factor are high. These conditions favor the use of the Diesel engine.

2—Interest and redemption (amortisation) are of chief influence on the total power cost with low B.t.u. price and low load factor. This applies particularly to stand-by plants, which are operated only occasionally or have to supply recurring peak loads. The installation cost of such plants must be kept as low as possible so as to avoid heavy capital charges distributable over a relatively small kilowatt-hours output of the station. Such conditions favor the steam turbine.

3—Exceptions to (2) are cases where the constant and instant readiness of the Diesel engine give it preference, and installation cost is of secondary importance. Here it is necessary to balance the cost of keeping boilers under steam continuously against the difference of interest charges of steam turbine and Diesel engine plants.

4—For power plants erected at the source of the fuel, either in the oilfields, or at the coal mine, prime movers will be selected, costing least to instal, i.e., steam turbines, since fuel expenditures will weigh less than interest and redemption charges.

5—In many cases combination plants using Diesel engines for supplying the continuous and nearly constant main load, and steam turbines for furnishing periodically occurring peaks by the use of high-duty boilers with large water and steam spaces, capable of being forced when necessary, will prove most profitable.

6—Steam power will remain the cheapest power wherever waste-heat gases are available, as, for instance, gases from reverberatory smelting furnaces, where nearly one-half of the fuel used in smelting can be utilized for steam generation. Nearly 3,000,000 B.t.u. for every ton of charge smelted are thus available

for steam generation, or about 150 horsepower hour per ton of charge.

7—Up to capacities of 1,000 horsepower steam turbines can compete with Diesel engines only in special cases, such as supplying exhaust steam for heating purposes. For such small units, particularly for greatly varying loads, reciprocating steam engines are preferable. For larger plants, from 1,000 to 10,000-kilowatt capacity, careful analysis must be made of the relative advantages of Diesel engines and turbines, a knowledge of the load factor, fuel prices, and water conditions being necessary. For power plants larger than 10,000 kilowatts, using units from 6,000 kilowatts upward, steam turbines have the preference, unless a combination of high load factor, high fuel cost, and poor water conditions favor a Diesel plant.

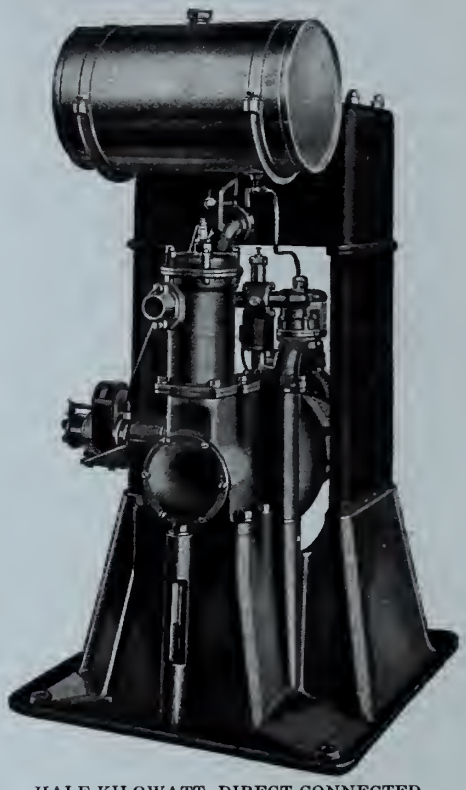
VERTICAL VS. HORIZONTAL DIESEL ENGINES

ONE of the outstanding features of Diesel-engine manufacture in the United States, says S. B. Daugherty in an A. S.M.E. paper, is that, in general, those manufacturers who have done their own designing have brought out horizontal engines, while those who are building vertical engines have purchased the designs abroad. The advantages of the horizontal engine, as enumerated by a concern with an established reputation as builders of vertical engines are: lower price; easy survey and convenient attendance; better distribution of stresses on the crankshaft and main bearings; better lubrication of bearings; better lubrication of piston; easier cleaning and repair work, especially to pistons, which can be taken out without removing the cylinder head and the valve gear; reduced height of engine room, as all pipes are laid in trenches under the floor and do not obstruct the room.

The Piston Detail

In a comparison of vertical and horizontal Diesel engines the detail most discussed is the piston. Vertical builders call attention to the weight of the piston, and the side pressure thereby produced on the cylinder bore, in the case of the horizontal engine. The fact that the first Diesel engines were built vertical, and that excessive height was undesirable, probably led to the use of trunk pistons. For the same reason a connecting rod of a length but slightly more than five cranks has been used in vertical engines. An analysis of the forces prevailing throughout the cycle of operations shows that the side pressure on the cylinder walls, due to the angularity of the connecting rod, is far greater than the pressure due to the weight of a piston, even though the piston lies horizontally. Any increase in connecting-rod length means a proportional decrease in the side thrust. Ordinarily an increase in the length of the connecting rod of one crank length decreases the side thrust an amount equal to the weight of a piston and wrist pin, or, in other words, a vertical trunk-piston engine with a connecting rod five cranks long is subjected to about the same side pressure on the cylinder wall as a horizontal trunk-piston engine with a connecting rod six cranks long.

It makes but little difference whether an engine is built vertical or horizontal so far as side pressures are concerned. The advantage of the horizontal engine in general, and the crosshead type in particular, is in its superior accessibility. In the case of a vertical trunk-piston engine it is necessary to practically dismantle the engine in order to get at the piston, piston rings, or wrist-pin bearings. In most cases the valve gear



HALF-KILOWATT DIRECT-CONNECTED GASOLINE-DRIVEN LIGHTING AND POWER SET.

and the cylinder heads must be removed, the connecting rod must be disconnected at the crank pin, and the piston and piston rod then lifted out through the cylinder.

Compare this procedure with that necessary in the horizontal engine: The sheet-steel crank splasher is removed; then the connecting rod is disconnected at the crank pin in the case of a trunk-piston type, or more simply at the wrist pin if the engine has a crosshead, and the piston is then removed from the open end of the cylinder. The actual time required to remove a piston and cross head of a 19-in. by 33-in. engine was twenty minutes. The piston was wiped clean and replaced in thirty minutes, making the total shut-down fifty minutes, as compared with about one day of ten hours to accomplish the same thing in the case of a vertical engine.

½ K.W. DOMESTIC LIGHTING AND POWER PLANT

THE problem of designing a home-size lighting plant is one which has engaged the attention of electrical engineers for some time, with varying degress of success. Belt-driven and direct-connected sets with self-starting arrangements, etc., have been available to small power users such as farms, country churches, camps, railroad stations, and isolated inns and boarding houses, but the designs of the set illustrated herewith have made departure from the present tendency by discarding belts, storage batteries and starting devices, and have developed a unit which is claimed to be capable of running continuously night and day if required, the cost of the comparatively idle extra running being less than that of storage battery depreciation.

The engine end of the Uni-Lectric lighting and power plant is shown in the engraving, the rated capacity of the set being 500 watts (½ k.w.) at 110 volts, direct current. A generous overload capacity renders it capable of running fifty 15-watt lamps, or any combined light and power load up to 750 watts, so that two motors of ½ horse-power each may be run from it.

The well-known efficiency of the sleeve-valve type of engine over long periods of continuous operation induced the designers to adopt this principle. The 4 stroke-cycle is employed with a single cylinder of 2¼ in. bore and 3 in. stroke. The sleeve, however, is of the revolving type which thus leaves the piston and piston rod as the only reciprocating parts in the entire construction. The cylinder casting is provided with exhaust and intake ports, and the sleeve which is carefully ground to a proper fit is arranged with two diametrically opposite ports for registration with the cylinder ports. The piston is located inside the sleeve and reciprocates in it as though it were the true cylinder. The sleeve is driven at only one revolution to four revolutions of the crankshaft, its two ports acting alternately as exhaust and intake.

The cylinder, as can be seen, is bolted to the crank case, which carries a single long crank shaft bearing; the armature shaft is tapered and fits into the end of the crank shaft so that it becomes integral therewith, the free or commutator end of the armature shaft being carried in a ball bearing. Forced automatic lubrication by pump is provided to all moving parts except this ball bearing, which only requires attention every month or so.

The entire generator is housed in a casing bolted to the end of crank case, and cooling water hopper and fuel tank are conveniently mounted overhead. Magneto ignition and automatic carburetor and governor are provided, the net weight of the apparatus being 375 lbs., and floor space occupied 24 x 25 in., with a height of 45 in. The Waterman Motor Co., Detroit, Mich., are the builders of this outfit.

REFRIGERATION DEPARTMENT

REFRIGERATION AND REFRIGERATOR INSULATION*

THE idea seems to prevail that a refrigerator door should have bevelled edges, and that these bevelled edges make a very tight door. How this idea originated it is beyond the writer's power to divine. As a matter of fact, such a door can be tight only if it happens to be very carefully fitted. As soon, however, as the moisture begins to have its inevitable effect, the door cannot by any chance be tight. Furthermore, if the hinges yield at all, as they are certain to do with a heavy refrigerator door, it will never be tight, even though it does not warp at all.

In the writer's opinion there is only one practical way to make a tight refrigerator door, that is, to have a plane surface come up against a plane surface with a flexible gasket between these two surfaces. It may also be possible to have a pair of such surfaces, or, rather, two pairs of such surfaces with gaskets between them, making an air pocket between the two seals. If this arrangement is used the door can sag considerably without causing any serious binding or failure in tightness. This matter of a satisfactory refrigerator door cannot be emphasized too much.

Refrigerating Capacity

In estimating the capacity of a refrigerating machine required to take care of a given refrigerator, it is not sufficient to calculate the heat loss through the insulation of the refrigerator. In fact, this loss in many cases is very much smaller in proportion to the total loss than the average engineer realizes. It is proportionately so small, in fact, in the case of ordinary household refrigerators, after comparing the ice consumption in well and in poorly insulated boxes, use very low grade insulation in their stock boxes. Their custom, in general, is to reduce the size of the air passages leading to and from the ice compartment to a very small area and thus, by restricting the flow of air over the ice, they reduce the meltage to a minimum. The average purchaser of one of these refrigerators is more interested in economy of ice than he is in the temperature to be secured in the box. He assumes that the temperatures are all right, but he knows each month whether or not the economy is right, when the iceman's bill comes in.

*Part II. of a paper read at the 24th general meeting of the Society of Naval Architects and Marine Engineers, New York City.

Heat enters a refrigerated compartment through five avenues: — First, through the walls, i.e., through the insulation; second, in warm goods; third, by the interchange of air through the opening of doors and by air leaks through defective insulation or through defective doors, cold air being heavier and immediately flowing out when doors are opened; fourth, from lights or from the heat of the bodies of workers; and fifth, from any change of state occurring in the goods, such as freezing, fermenting, etc. In large rooms these various losses of heat should be analyzed separately. In small refrigerators, such as those for hotels, kitchens, private homes, the average galley refrigerator and so on, a rough rule that gives quite as accurate result as a more elaborate analysis allows for a certain number of British thermal units per cubic foot of refrigerator per 24 hours, for instance, 1300 British thermal units per cubic foot for an average pantry refrigerator. If the box is located in a kitchen, as in a hotel or restaurant, it is safer to allow about 600 British thermal units; and if the kitchen is especially warm, as many galley kitchens are, 900 British thermal units are safer, especially if the boxes are small.

For butchers' coolers or large boxes in hotels, i.e., large storage boxes from 6 feet by 8 feet to, say 10 feet by 15 feet, a safe allowance is, approximately, 200 to 250 British thermal units per cubic foot for 24 hours. In climates varying appreciably from the temperate zone, corresponding allowances must, of course, be made.

Suggested Scheme of Analysis

In general, the size of machine for a given refrigerator has to be decided upon before the refrigerator is put into service. On the other hand, where an existing ice-cooled refrigerator is to be cooled mechanically, one check on the size of the machine required is given by the amount of ice which has been used. This check is, however, more likely than any other to lead to wrong conclusions unless the figures are properly analyzed. The following is a suggested scheme of analysis:—

First, determine the average daily ice consumption for the summer months—say July or August—from the actual weighing of the ice, or from the ice bill.

Second, determine as accurately as possible the average temperature that was secured by ice in the refrigerator. This will usually be from 55 to 60 degs. and, although it is commonly stated as anywhere from 40 to 45 degs., these lower figures are so seldom obtained day in and day out as to practically warrant the statement that they are never reached. It is only with a full ice chamber and with the box closed for long periods that such low temperatures can be secured, and even under these conditions the average temperature will still run well above these figures.

Third, calculate the heat inflow through the insulation with the temperature in the box as actually observed or as assumed, and with the average summer temperature prevailing outside. The difference between the heat inflow through the insulation and the total heat actually absorbed by the melting of the ice is the amount of heat entering the box fro mother sources than through the insulation. This excess of heat ordinarily occurs during the day time only, i.e., when the box is being opened, since at night the box remains closed. A machine, to be of sufficient capacity to produce the temperature actually obtained with ice, therefore, must be large enough to absorb the heat inflow through the insulation and also the additional heat entering during the daytime from other sources, i.e., to take care of this entire load during the day. Stated in another way, the machine must be large enough to absorb, during the daytime part of its run, half of the total insulation loss plus all of the balance of the loss.

Fourth, a further fact to be taken into account in determining the proper size of machine is that the temperatures which are obtained with ice are not satisfactory. If they were satisfactory, one of the greatest reasons for putting in cooling machinery would be void. Where a temperature of 55 degs. can be obtained with ice, 35 to 45 degs. will be demanded of mechanical cooling. Therefore, the machine size must be further increased in proportion to the number of degrees difference of temperature required. For instance, if the outside temperature is 71 degs. and the temperature desired is 35 degs., where the ice temperature has been 55 degs. the machine size must be increased in the proportion of 71 minus 35, divided by 71 minus 55, or 2¼ times.

Fifth, furthermore, if the cooling machine were installed in accordance with these figures it would handle average summer weather conditions, but would be insufficient for extreme hot weather, the most important condition to be met by refrigeration. It is necessary, there-

fore, to further increase the size of the machine in the ratio of the difference between the maximum summer temperature and 35 degs. and the average summer temperature and 35 degs:

Sixth, one further allowance should be considered, namely, the fact that in many cases, for one reason or another, it is either impossible or undesirable to operate the machine except during certain parts of the day. The machine size must, therefore, be increased by as much as may be required to produce the desired amount of refrigeration in the short time available.

Seventh, and finally, if the machine is not placed directly beside the box to be cooled, allowance must be made for the heat inflow into the insulated cold main. The amount of heat entering from this source is often of considerable importance, particularly with small machines.

Individual Case Application

When one comes to apply these figures to an individual case the size of machine is apt to work out so large as to be rather startling. There are so many elements that are entirely uncertain, such as the kind of workmanship in the insulation, the amount of leakage through doors, the kind of care the refrigerator will be given, the probability of the doors being left more or less ajar; there are, in fact, such a multitude of very uncertain elements that considerable leeway ought to be allowed in the size of machine.

Where the amount of refrigeration is large, as in a good-sized storage warehouse, one can always throw a large part of the machine capacity to any given box where special need exists. To do this with a small machine would almost certainly rob some other box, if indeed there happened to be another box to rob. One cannot emphasize too strongly, therefore, the importance of having ample capacity in small refrigerating machines. In installing cooling surface in refrigerators it is often necessary to arrange the layout as one can, rather than as one would like to do it. If efficiency in the use of the cooling surface is the only consideration, a lower temperature can be secured in the refrigerator by placing the coils directly on the ceiling than in any other way. An arrangement of this kinds, of course, is sure to keep the box rather moist and, except in rare instances, is not permissible.

In a great many cases the only thing that can be done is to place the cooling surface directly on the walls of the box. There are, with this arrangement, several disadvantages. In the first place, goods that are stored on shelves close to the coils are apt to be pushed against them, and constant care is essential, and unfortunately rarely given, to keep the coils clean. Goods placed near the coils are also colder by far than goods toward the middle of the refrigerator. There is no direction given to the circulation of the air—that is to say, there is apt to be considerable eddying between the rising and the falling currents of air so that the circulation is often rather sluggish.

Deposit of Moisture

There is often considerable trouble from deposit of moisture on the walls of the box in this arrangement. When the box stands closed for a considerable period, the walls and ceiling become quite cold by direct radiation to the coils. When the door of the refrigerator is open, the cold air in the box rushes out, and warm air, often heavily laden with moisture, comes in. This warm air strikes the surfaces and immediately deposits moisture, often to so great an extent as to cause serious dripping from the ceiling on to the stored goods. Frosting on the walls is of course caused in the same way, but is not so serious on account of the element of dripping on to goods being absent.

This deposit of moisture on the ceiling of the refrigerator is especially apt to occur at a point farthest from the cooling surface on the walls. This is due, undoubtedly, to the sluggish motion of the air in this part of the refrigerator, the circulation being considerably better nearer the coils. The air, which has been more or less dried by the deposit on the cooling surface, gradually dries the surface with which it comes in contact as it circulates.

The best arrangement of cooling surface in the refrigerator is either to place it in a loft above the box, i.e., above the storage compartment, or in a space alongside of this compartment, with ample air passages to permit the circulation of the air between the two compartments. This arrangement is, of course, inefficient as regards the use of the cooling surface, but gives a very much more satisfactory refrigerator. Moisture is deposited on the coils, the air passes back to the refrigerator partially dried, and, if the box is properly proportioned, the air in passing over surfaces of the refrigerator, as well as over the goods, dries them and keeps them in good shape.

Large Air Passages

Comparatively few refrigerator builders have any realization of the vital importance of having large air passages, or, if the builders of ordinary household refrigerators have this appreciation, they use it to the disadvantage rather than the advantage of their design so far as its use to the purchaser is concerned. As already pointed out, if the air passages in a refrigerator are choked down, there will be little circulation of the air, and the refrigerator will therefore be economical of ice. It will be a refrigerator, however, in name only. The force that causes the circulation of air in a refrigerator is extremely minute, being only the difference of weight between the air in the coil compartment and that in the same height of the food storage compartment. If there is a difference of even, say 15 degs. in the temperature between the two compartments the excess weight in the one over the other is obviously extremely slight.

The writer had an opportunity several years ago to make an experiment on refrigerator temperatures that brings out this point very clearly. The cooling surface of a section through the refrigerator, which was about 8 feet wide and 6 feet high, was located in the middle of the apparatus with a baffle plate on each side of it, and the passages for the air were identically the same on both sides, except that the space leading from the storage compartment to the coil surface at the left was 3 inches and that at the right was 4 inches. The difference of 1 inch in this one dimension made a difference in the temperatures observed at the points marked A and B of one degree, throughout a week test.

When one considers that the average household refrigerator has air passages from 1 to 2 inches (rarely more than this) in depth, and when the average large refrigerator has only 3 or 4-inch passages, in a very great many cases, the desirability of further attention to this element in the design of refrigerators is apparent.

Refrigerating Machines

The writer will not attempt any elaborate description of the various types of refrigerating machines that are used in marine work. As a matter of fact, practically every type of machine that is built has been given more or less trial in this service. He will only attempt to call attention to a few of the considerations that seem important in determining the type of machine suitable for any given installation.

Air Type

For a number of years the only refrigerating machine that seemed entirely safe for use on board ship was the air machine, especially as embodied in the Allen dense air machine. The skill required in the operation of these machines and their enormously high cost of operation was more than counterbalanced by the freedom from danger from escaping gases that they gave. There was no need to carry a supply of flasks containing gases at high pressure; there was, therefore, freedom from any danger to the ship from the presence of these gases, and there was no danger that the machine would be shut down from lack of chemicals. There was, of course, considerable danger of derangement of the machine in case it was not skillfully handled, and, as already suggested, the cost of operation was so high that, except for relatively small sizes of machines, the use of this design of machine was prohibitively expensive.

Ammonia and Carbonic Acid Types

In cases where the escape of gases would not be serious and where, on the other hand, cost of operation would be an important item, and where large quantities of refrigeration were required —especially in cases where a separate engine-room could be provided for the machine—the ammonia and carbonic acid type of machine has been the ruling type. In the merchant service there are a number of these machines placed directly in the main engine-room. It is unnecessary to dwell upon the matter of locating the machine in this way to the engineer who has been through the experience of an accident or the unexpected escape of gases. For the engineer who

has not been through an experience of this kind, discussing the subject will not carry great weight. Human nature nature seems very much to prefer the process of locking the stable after the horse has been stolen.

As has already been indicated, the ammonia or the carbonic-acid type of machine is undoubtedly the best type of machine for cases where the capacity required is considerable, and where a separate engine-room can be provided. In the choice of machines for this service there is a selection to be made between the open type of machine in which the stuffing box is arranged on the piston rod, and the enclosed crank case type. In larger units the open type of machine is, of course, almost invariably used. In the writer's judgment this type of machine is distinctly better for the small as well as for the larger work. The open-type machine has the advantage in the matter of taking up wear and constantly and readily keeping the machine in its best state of efficiency. It has the further advantage of not wearing nearly as rapidly as does the enclosed crank-case design.

Detail Features

Consider, first, the matter of the stuffing box. Where this is on the piston rod, and especially where the stuffing box is fitted with springs and with an oil lantern connecting to the low-pressure side of the machine, it is possible to run with a stuffing box so loose that the outer gland moves back and forth against the springs with each stroke of the piston and yet with no odor of ammonia discernible. The wear on the piston rod in this case is relatively small. Compare with this the wear on the stuffing box on the shaft of an enclosed crank-case machine. The wear on this shaft is concentrated at one particular point. The stuffing box is ordinarily not difficult to keep tight or approximately tight, but when it comes to replacement the piston rod of the open-type machine is a very much less expensive part to replace, and one very much more easily replaced than is the crank-shaft of the enclosed-type machine.

The capacity of a refrigerating machine, of course, falls off with increase in the clearance in the cylinder. A moment's consideration will show very clearly the simplicity of adjusting clearance in the open type of compressor and the very serious difficulty in making the corresponding adjustment in the enclosed-type machine.

Audiffren-Singrun Machine

Turning now to the Audiffren-Singrun refrigerating machine, in this type of machine the problem of a stuffing box is met by closing all the working parts of the machine within a hermetically sealed drum. The machine consists of a shaft with a pulley at one end, a drum at the other end, and a second drum at the middle of the shaft. The machine is carried in two bearings, one on either side of the central drum, and revolves with the central drum in contact with flowing water. The compressor, which is reduced to its simplest element because of its peculiar situation, hangs loose on the shaft inside the condensor drum and is held in position by means of a counterweight. The dumbell is sent out from the factory completely charged and ready to operate. The air is entirely exhausted and a charge of sulphur dioxide and a pure neutral oil is admitted, after which the machine is hermetically sealed. The working parts are thus constantly lubricated, and the pressure in the condenser is constantly forcing oil between the working surfaces of the compressors. Oxidation of the lubricating oil cannot occur as there is no oxygen present. It is impossible to draw air into the machine because the dumbbell is hermetically sealed. No dust can get access to the working parts, and, as a consequence, the wear on these machines is reduced to a minimum.

Operation Features

In a machine of this type the gas enters the compressors in practically a saturated condition. In consequence of this the compressors always operate automatically at maximum capacity, and there is no superheating of the gas with consequent loss in capacity. The brine returning to the machine from the cooling surfaces in the refrigerator overflows from the inner tank to the outer or surge space, whence it is drawn by the pump and again circulated through the cooling surfaces. The arrangement of inner and outer tank avoids the possibility of spilling of brine with the motion of the ship. A similar arrangement is provided for avoiding any spilling of condensing water in the condenser tank.

Where ice is required in addition to cooling refrigerators, either one of two arrangements has been used. One arrangement consists of closed coils through which the brine circulates with an auxiliary bath of brine in which the ice moulds are placed. This latter arrangement of ice making tanks cannot be placed high enough to insure flow of the brine back to the evaporator or brine-cooling tank. It has the disadvantage, of course, that the brine has to be circulated at a lower temperature than in the case of the open system.

With this refrigerating machine it is possible to place the machine close to the refrigerator on account of the simplicity of its operation and the very small amount of care that is necessary, since there is no necessity for watching expansion valves or stuffing boxes, or anything of that kind. This, of course, means a considerable saving in heat losses through the piping, which losses are in the case of small work, such as refrigerating work on board ship ordinarily is, quite important. The condenser tank in this installation is practically identical with the usual tank for standard marine work. The brine tank, however, is provided with a labyrinth where the shaft of the machine enters the tank to prevent spilling of brine.

The circulation of the brine through the coils in the refrigerator is secured by the action of the machine itself, which throws the brine into the hood or scoop whence the brine flows by gravity. The design of the refrigerator has also been carefully worked out, so that in storing goods in the box it is very difficult, if not impossible, to entirely block the air passages. Space is also provided so that cooling coils for drinking water may be placed directly below the brine coils, and in a number of instances this space has been so utilized.

INCREASED TAX ON WAR PROFITS

THE resolution brought down by the Minister of Finance, in the House at Ottawa, to give effect to the proposals contained in his budget speech provides:

1—That in any business taxable under the Act where the annual profits exceed 15 per cent. per annum, the tax shall be increased to 50 per cent. with respect to all profits in excess of the said 15 per cent., but not exceeding 20 per cent. per annum, and where the profits exceed 20 per cent. per annum the tax shall be increased to 75 per cent., with respect to all profits in excess of the said 20 per cent., and such increases as the tax shall be levied against and paid by the person owning such business for each and every accounting period ending after the 31st day of December, 1916.

2—That for the purposes of the said Act, the actual unimpaired reserve, rest or accumulated profits shall, at the commencement of an accounting period by an incorporated company, be included as part of its capital as long as it is held and used by the company as capital.

That any enactment founded on this resolution shall be deemed to have come into force on and from the 18th day of May, 1916.

3—That the tax shall be paid each year within one month from the date of the mailing of the notice of assessment.

4—That with respect to every business liable to taxation hereunder the period for which the returns shall be made and during which it shall be liable for assessment shall be at least thirty-six months, commencing with the beginning of the first accounting period ending after the 31st day of December, 1914, or for such less period as the business may have been carried on from the beginning of the said accounting period to the end of the period for which the said tax may be levied under the said Act.

The following table illustrates the division under the new Profits Taxation Act of a company's profits between the company and the Government:

Profit	Company	Government
10 p.c.	9¼ p.c.	¾ p.c.
15 p.c.	13 p.c.	2 p.c.
20 p.c.	15½ p.c.	4½ p.c.
25 p.c.	16¾ p.c.	8¼ p.c.
30 p.c.	18 p.c.	12 p.c.
50 p.c.	23 p.c.	27 p.c.
100 p.c.	35½ p.c.	64¼ p.c.
200 p.c.	60½ p.c.	139½ p.c.

Trouble Either Way.—"I understand your automobile has gotten you into trouble."

"It's always getting me into trouble, one way or another," replied Mr. Chuggins. "When it runs, I get arrested for speeding. When it refuses to run, I get arrested for profanity."

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Vol. X. MAY, 1917 No. 5

PRINCIPAL CONTENTS

Development Towards New Type of Steam Safety Valves.....103-108

Power Transmission Section 109-110
Turbine Gearing....Variable Speed Transmission Devices ....Fabric Brake and Clutch Linings....Ball Bearings.

General 110
Powdered Coal as Fuel.

Steam and Its Generation 111-112
Where Combustion Takes Place....Boiler Troubles Due to Foaming or Priming....Blowing-off Boilers....Advantages and Disadvantages of Powdered Fuel.

General 112-113
Reducing Friction by Automatic Lubrication....Safety Rules for Small Refrigerator Machines.

Electricity and Hydraulics 114-116
Steel Mill and Central Station....Diesel Engines vs. Steam Turbines....Vertical vs. Horizontal Diesel Engines.... ½ K.W. Domestic Lighting and Power Plant.

Refrigeration 117-119
Refrigeration and Refrigerator Insulation.

General 119
Increased Tax on War Profits.

Editorial 120
Certificates as Guarantees of Ability .... Canada's 1917 Budget.

Spokes in Industry's Wheel 121
William Martin McRobert.

The Operators' Point of View 122-124
Calculating the Weight of a Flywheel....Adapting Gasolene Engines to Burn Kerosene....Doesn't Believe in Saving Time....Overcoming Trouble With Steam Pipe....Cylinder Iron....An Oil Separator....Blow-off Tank....Domestic Water Heater.

Question and Answer Section 125

General 125-126
C.A.S.E. Convention and Supplies Exhibition....Canadian Electrical Association....Grand Lodge C.A.S.E. Incorporation.

Steam Power Plant Auxiliaries 127-129
Oil Separators—II.

General 129
Lift and Force Pumps....Graphite Lubrication for Cylinders ....The Effect of Storage on Coal.

Progress in New Equipment 130
Automatic Temperature Control....Anti-Acid Valves.

Selected Market Quotations (Advtg. Section) 48

Projects and Developments 50-52
Trade Gossip....Catalogues.

CERTIFICATES AS GUARANTEES OF ABILITY

THE demand for efficiency, now more urgent than ever before, might well be advanced as an argument for indicating, in a suitable manner, the degree of qualifications possessed by individuals where their possession of ability in certain lines is the prime reason for their employment. Power house operatives, from chief engineers down to coal trimmer, can perform team work of a most valuable nature, or on the other hand, by working at cross purposes or by studied indifference increase operating costs tremendously.

The possession of a certificate issued by a Government department may testify that the holder possesses certain experience and knowledge which qualifies him to hold a certain position, but another with a similar certificate may be capable of holding a much more responsible position and yet be unable to obtain official evidence of his superiority.

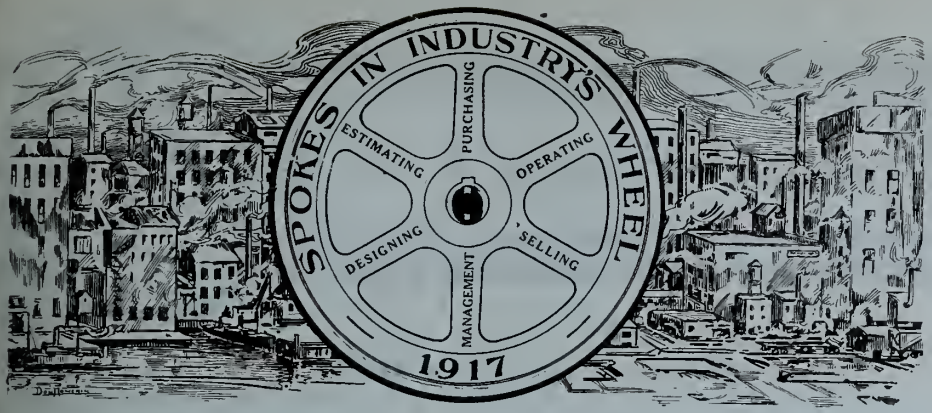
Power house engineers are just as human as other people, and take as high a pride in their work individually, but ability is no more uniform with them than with other crafts, and the employer who wants the best has no means of judging except by "trying out," a process which must be repeated each time a vacancy occurs unless suitable candidates for promotion are available.

Requirements of present-day power plants are often such that personal ability is required much in excess of that indicated by a "flat grading," so to speak, which must of necessity be moderate enough to cover the most insignificant of operating requirements. The ambitious and experienced operator can be justly excused if he feels that fuller recognition of his greater fitness should be given. Such action in the form of graded certificates would be to the benefit of the employer no less than to the engineer as an individual or to his profession as a whole.

CANADA'S 1917 BUDGET

IT may be said of our Finance Minister's Budget, brought before the House of Commons, Ottawa, during the present month, that its substance is nothing more or less than an expansion of the scheme of taxation of war profits, now operative. In another section of this issue a condensed detail is given of its leading provisions. Considered either apart from or in conjunction with the present war taxes, or an income assessment, there are other taxes which, if made immediately effective, would help to pay our war debts as we go with no other effect than checking public extravagance of which there is so much evidence.

If the tax on automobiles were increased by $10 there would be no burden on anyone who could not well bear it. The amount would be large and could be readily collected. In fact it is a tax which might well be continued after the war and the fund used to the betterment of the national highways. The tax on theatre tickets could well be doubled, its proportions being such that its imposition would be least felt by those concerned. It is a tax which would be no great burden to judge by the crowds attending houses of expensive entertainment particularly. Even if the crowds were decreased there would be no great harm done, besides the public spirit would be directed to things more appropriate to this war time. In addition to the foregoing, there are numerous other commodities in the nature of luxuries which might similarly constitute a means of increasing national funds without affecting, at least, the "cost of living."



The constitution of industrial enterprise is largely departmental—"Spokes in a Wheel." This series has for its object the featuring of, in racy, interesting and instructive fashion, the training, experience and achievement of those who to-day are transmitting effectively, energy in a variety capacity as "Spokes in the Wheels" of steam, electrical and hydraulic and refrigeration engineering.

WILLIAM MARTIN McROBERT

AT a time like the present, when surmises regarding future conditions are being made on all sides, and the probability of intensified competition looms up as a result of Britain's industrial awakening, it is reassuring, to those solicitous of Canada's future, to know that a prominent feature of the rising generation of engineers is the large number who, by birth, ancestry, or educational experience, have been able to absorb to a large degree those characteristics of the British race which, in view of future possibilities, may afford apt illustration of "diamond cut diamond."

A prominent English engineer, with world-wide experience, once remarked that Scotland was all right for breeding men, but was no use for feeding them. There may or may not be any truth in the latter part of the statement, but many of our readers who are acquainted with William Martin McRobert, sales engineer of the Galt Foundry Co., Galt, Ont., will be in perfect agreement that a deal of truth is contained in the first part of the remark.

Mr. McRobert is a native born Canadian, having first gazed upon the maple leaf in the immediate environs of London, Ont., in the year 1876. When three years of age his parents returned to their native land and settled in Aberdeen, Where our "Spoke" spent his early years, his education being received at Aberdeen Grammar School and Gordon's College. That he had early absorbed a due share of that determination and tenacity which are so authentically attributed to residents of the "Granite City" was evidenced by his decision to go through the mill as an apprentice engineer.

Much has been written and said regarding the value of experience in the eyes of Scotch people, and a recital of apprenticeship conditions under which our friend gained his knowledge of wheels and things may account in some measure for this trait. Commencing early in his teens, he started work at 6 a.m., quitting at 5.30 p.m., with two stops for breakfast and dinner. The remuneration offered seems to have been in inverse ratio to the hours worked when judged by Canadian standards. For instance, we are informed that the young apprentice was rewarded with the sum of 75c per week the first year, with annual increments of 25c per week up to the sixth year. Technical education was obtained through evening studies at the local Technical School over a period of four years.

WILLIAM MARTIN McROBERT

These conditions easily made it a case of the survival of the fittest, a further test of tenacity being the necessity of making up all lost time as double hours before the youthful journeyman received the coveted "lines," i.e. certificate of apprenticeship. Some certificate!

Dalgety Brothers, Aberdeen, was the firm where this training was undergone, and a short time afterwards our friend entered the service of the "P. and O." line of steamships, climbing through the various grades to the rank of service engineer, for which it was necessary to pass the Board of Trade examination for first-class engineer. A decade spent on ocean mail steamers familiarized Mr. McRobert with the operation and upkeep of power plant equipment to a degree seldom obtaining in land installations. The necessity for avoiding breakdowns at all costs, and the limited facilities for effecting repairs in case of accident developed an alertness and self-reliance which is typical of the modern marine man. It is not surprising, therefore, that when, after ten years of sea life, our "Spoke" decided to settle in the land of his birth, he was appointed chief engineer of the Canada Foundry Co., Toronto, a position which he held for three years before transferring his services to Gunns, Ltd., Toronto, in a similar capacity, but with the additional duties of master mechanic.

As sales engineer for the Galt Foundry Co., Mr. McRobert finds ample opportunity for drawing on his wide experience, his energies being devoted to the development of the Galt sprinkler stoker and the McNaughton grate bar. No combination of circumstances is likely to offer very great difficulty in the application of his personally acquired knowledge of things mechanical. In the course of his travels Mr. McRobert has had frequent opportunity of studying industrial practice in nearly every civilized country, having, with the exception of Northern Europe and South America, visited every part of the globe. His travel record includes over 70 passages through the Suez Canal, and also coast to coast trips in Canada and United States.

Mr. McRobert's home life is centred in Toronto, where he resides at 92 Symington Avenue, his son being a student at Toronto Technical School preparatory to following a kindred career to that of his father. His experience in occasionally isolated situations gave Mr. McRobert more than ordinary opportunity for appreciating the value of technical study, in fact, he considers that for any engineer or mechanic having ambition to advance in his profession it is imperative that he should keep abreast of the times by combining with his practical knowledge the study of reliable engineering literature, also the reading of the many interesting and instructive articles appearing in the current issues of mechanical trade journals.

—⚙—

At a picture-house the other day a picture was shown entitled:

"As God Made It."

Immediately following the projection of the title on the screen came the flash:

"Approved by the Board of Censors."

The Operators' Point of View

CALCULATING THE WEIGHT OF A FLYWHEEL

By D. A. Hampson.

THE weight of a flywheel needed for a machine which does all of its "work" during only a portion of its cycle can be determined by well-known formulae if certain assumptions are made and if the work can be expressed in foot-pounds. The most familiar machines requiring flywheels to balance work of this sort are punches and presses for sheet metal working. With these the work is done during a portion—say from one-tenth to one-half of the downward stroke; the remainder and all of the upward or return stroke are idle movements, simply overcoming the friction of the machine. As the belt is constantly running, it is the function of the flywheel to store up enough energy during the idle portion to overcome the resistance of the working portion of each revolution.

The first step in the calculations is to put that resistance in terms of foot-pounds; then to find just what is the proportion of idle to useful time. This is usually a matter of measurement and is reduced to degrees about the flyweel centre, for instance—20 degrees working, 340 degrees idle. If the number of revolutions per minute of the flywheel is known, this is again reduced and expressed as "seconds working," "seconds idle." If the speed is not known, one must be assumed for calculating purposes.

There must also be known, or assumed, the reduction in speed which the flywheel makes during the working period. This is an important factor and in the case of a new machine must be assumed, basing the assumption on experience and judgment—it is commonly stated as "per cent. loss in speed while actually cutting." In the case of cutting, say a thin sheet of brass the loss will be perhaps only 5 per cent. or less; if the length of the cut in the direction of the stroke is considerable, the loss may run high, perhaps 25 per cent.

Example of Application

Paper cutting machines are fine examples of the case where the length of the cut is a major part of the stroke. The vertical travel of the cutting knife may be 5 in. and for this size of machine the capacity would be at least 4½ in. of paper. This is many times the proportion found in machines for stamping sheet metal and furnishes a very interesting example for flywheel design. It is obvious that either a very heavy flywheel must be provided or else there will be a big reduction in speed when cutting, for if the wheel is not heavy enough, the machine will run slower and slower as the knife cuts downward and may even stop if the flywheel cannot give up energy enough to carry past the lowest point. A special paper cutter, built on much the same lines as an open side punch press, furnished a problem which the following calculations successfully solved: The data determined and assumed were as follows:—

1,050 lbs. pressure required back of the knife to do the cutting.

3 in.=stroke of press.

2 in.=1/6 ft.=length of cut in direction of stroke.

60 rev. per min.=60 cutting strokes per min.

Cut=110 deg. or .3 sec., idle=250 deg. or .7 sec.

18 in.=1½ ft.=mean diameter of flywheel rim.

Total energy required for the cutting stroke=1050÷6=175 ft. lbs.

The following formulae are now applied.

$$(1)\ \text{H. P.} = \frac{\text{ft. lbs. reqd.} \times \text{rev. per mm.}}{33{,}000} = \frac{175 \times 60}{33{,}000} = 32.$$

$$(2).\ E_1 = \text{ft. lbs. reqd.} \times \left(1 - \frac{\text{sec. of actual cut}}{\text{total time of stroke}}\right) = 175\left(1 - \frac{.3}{1}\right) = 122\tfrac{1}{2}\ \text{ft. lbs.}$$

$$(3).\ \text{Wt.} = \frac{E_1}{\text{constant} \times \text{dia.}^2 \times \text{rev. per min'}} = \frac{122\tfrac{1}{2}}{.0000118 \times 1.5^2 \times 60^2} = 1281.$$

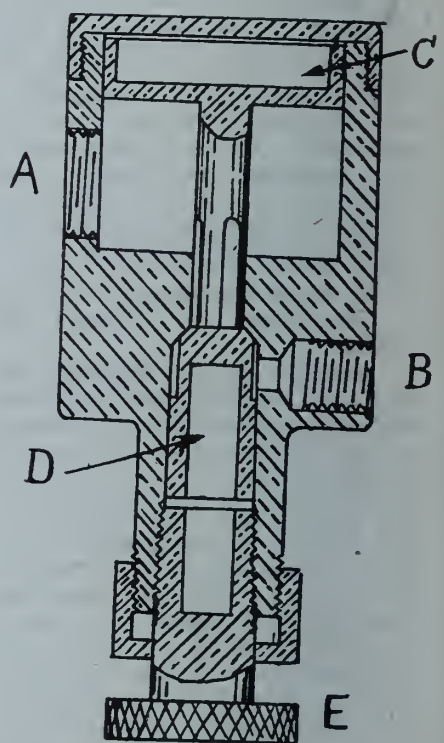
The constant in the denominator of (3) varies from .000002 for 2¼ per cent. loss to 000015 for 20 per cent. loss.

Formula (1) is not necessary to the flywheel calculation but gives an idea of the work to be done and the sizes of belt or motor needed. After the weight is found, the section of the rim necessary is a matter of adjusting width and thickness to other conditions. The entire calculation is free from complication and answers for all simple cases.

ADAPTING GASOLINE ENGINES TO BURN KEROSENE

By H. P. Hoag

AS THE price of gasoline advances the interest in the cheaper fuels for the gas engine increases and some experiences the writer had in adapting a line of standard gasoline engines to burn kerosene and naptha may be timely. The experiments covered a period of nearly two years before the following points were finally settled on. 1st: It was found that heating the air entering the carburetor reduced the power of the



AUTOMATIC WATER VALVE.

engine to a very marked degree. 2nd: To give best results, kerosene and naptha should be heated nearly to the evaporating point before passing the spray nozzle. 3rd: Water must be admitted into the carburetor with the fuel to retard the burning and give smooth running.

Heating the air was advocated by a number of writers but it was found after trying out many hot air devices, some home made and others from abroad, that in every case the power of the engine dropped, in some instances to but 70 per cent. that of gasoline, so that the hot air idea had to be abandoned altogether, as the manufacturer could

not send engines out that would not develop their rated power no matter how well the oil was burned.

Fuel Heated

Heating the oil was accomplished by providing a separate chamber around the outside of the fuel reservoir in the carburetor through which water is circulated, this water being taken from the hottest part of the cylinder jacket. By this means the fuel is kept at the proper temperature and is warm enough by the time the engine is ready to turn on the kerosene; gasoline is used to start with.

Spraying water into the mixture gave a good deal of trouble, that is to get the proper amount for each charge, because when using a throttle governor it became evident that a fixed amount of water for each charge was not the thing, but that the quantity of water should vary according to the load or the amount of fuel taken in. Some means to automatically prevent water running into the cylinder when the engine was shut down was also required, as the operator could not be depended on to turn water off each time.

Use of Automatic Valve

To embody the above requirement the automatic water valve shown herewith was designed, the construction being as follows. In the upper chamber of the valve body there is an air piston C which extends down onto the small inverted valve D. The valve being held up to place by a light spring (not shown) placed inside the valve and the hollow adjusting screw. The opening A is piped into the carburetor between the spray nozzle and the throttle valve. Opening B is piped to a convenient place in the water jacket with a stop cock in the line for shutting off the water when using gasoline. The action is as follows, (the upper chamber being in communication with the carburetor): when suction takes place the piston C is drawn down against valve D, forcing it away from its seat by a varying amount according to the load on the engine, when the necessary amount of water flows past the valve D then the pipe from A into the carburetor entering the cylinder with the fuel. It will be noticed there is a fine threaded adjusting screw provided at the bottom to set the stroke of valve D to suit the size of the engine. It is obvious that with this device the quantity of water is varied according to the load also that no water can get past valve D into the cylinder when the engine is not running. With this arrangement it was found not only did kerosene burn(in the ordinary gas engine) as well as gasoline but usually eight per cent. more power was developed with the cheaper fuel.

DOESN'T BELIEVE IN SAVING TIME.

By N. G. Near.

BOILER factory owners still exist who think they have sound arguments against good time-saving devices. They believe in the old idea—plenty of "elbow grease" as they called it. They think it laziness to permit the brain to do the work through coal and machinery.

I met a friend salesman the other day who told me about an argument he had with such an owner of a boiler factory. He had tried to sell the owner an up-to-date, time-saving machine, but the owner said, "If we used every time-saving device in the world in this factory we wouldn't have anything more to do." Although it is usually fatal for a salesman to be sarcastic with a prospective buyer, this friend of mine said, "Your're right. Henry Ford believes in using as much time-saving machinery as possible in his automobile factory, and that is why he hasn't anything to do now-a-days."

It's a fact that some so-called time-saving machines are actually time-losers and they should be carefully weeded out. Again, the time-saving machine may be a time-saver only where it can do jobs over and over, and where it can be kept everlastingly at it. In many instances, holes can be drilled in certain pieces by hand more quickly and more economically than by machinery, and such machinery may be the so-termed "time-saving" variety.

If TIME was MONEY in Ben Franklin's day, doesn't it seem reasonable that time is worth MORE money now?

OVERCOMING TROUBLE WITH STEAM PIPE

By J. James.

IN your April issue, H. Westwood has something to say against the use of a receiver on a steam line. No doubt he is right if a continual increase in the quantity of steam required is needed; however, the scheme worked out on the steam line, as described in the January 1917 issue. According to theory, the idea is wrong, but Mr. Westwood apparently overlooked the statement that the scheme was tried out with success. All the figures and theory in the world will not change facts. Perhaps the engine required such a small quantity of extra steam that the slight reduction in friction and the separator effect of the receiver "did the trick." No doubt, if it had been allowable, the pressure in the boiler could have been raised a few pounds, and the use of the separator receiver dispensed with.

In 35 years' experience I have seen theory proved wrong more than once. What appeared impossible on paper would prove quite possible when tried out by some fellow who had very little experience as an engineer. Of course, we all know that such cases are the exception and not the rule, but there are exceptions.

Right in the plant where I am employed, there is an outfit connected that would make some engineers open their eyes in wonder. A 10 x 12 x 14 in. compound steam pump delivering 160,000 gallons of water every 24 hours, an 8 x 10 in. steam engine making 260 rev. per min., and a 5 x 6 x 8 in. steam sewage pump, have their exhaust pipes connected into one 2½ in. pipe. This pipe delivers the exhaust steam into a heating main 100 feet distant from the engine, and the pumps are 35 feet further along the line. The back pressure never exceeds 5 pounds and often not 2 pounds. Figure it out. The exhaust outlet on the large pump and the engine is 3 inch, the small pump 1½ inch. The steam main to the engine and compound pump is 2½ inches each, the small pump 1 in. Steam pressure 110 lbs. per sq. in. absolute. This is no job that was in existence in the dim and misty past; it is doing business at the time of writing and likely to be so doing for some years to come.

All we old stagers could tell about different schemes worked out on paper failing to work out in practice, and we have often been surprised to find what we considered impossible in practice was not so in fact. Without theory, steam engineering would be a very dull study, indeed, but theory is not perfection in itself.

I have figured on some house heating jobs, allowing so many feet of radiator surface, according to rule, per 100 feet of space, allowing for doors, windows, north and south walls, etc., etc., and some other fellow who did not place absolute trust in theory alone, but used judgment and common sense, would take the job away from me at a lower price, putting in about a third less radiation. I had figured on an abundance of heat at the lowest outside temperature to heat the house properly. Another case of theory gone wrong.

I have taken several courses of correspondence study and hold diplomas for same; I have first class papers from the old Ontario Association of Stationary Engineering, which quit in 1907, but I do not believe in sticking to theory, right or wrong. Experiment, try things out—it will often pay if the try out will not cost too much.

And, lastly, the receiver was not 8 feet in diameter; it was less than three feet, which, according to theory, looks worse than ever.

CYLINDER IRON

By T. J.

IF an examination be made of the surface of a cast-iron cylinder liner which has been some time in use, it will be found to be pitted with small holes. This is generally supposed to be due to the flaking off, or wearing away, of the soft graphite plates which lie between the harder grains in coarse grained cast-iron; but, as Mr. J. E. Hurst has recently pointed out, microscopical investigation suggests that this is only half the explanation. It appears that the wearing down of the inter-granular graphite is only a preliminary stage in the formation of the actual depressions seen with the naked eye on the worn surface.

What happens is that a certain amount of soft material is in the first place, detached, and some slight surface disin-

tegration caused under the abraiding action of the piston rings. Some of this detached material becomes powdered and suspended in the film of oil, and acts still further upon the surface until the softer portions are worn a little lower, and the harder grains project above the surrounding material, becoming still harder as a result of the polishing action of the piston rings. Eventually some of these projections are loosened and break away from their groundwork, leaving hollow places behind them. These are the holes which show themselves on the surface of the liner that has been some time in use, and this appears to be the mechanism of surface disintegration in engine cylinders. The glazing of the hard grains in cast-iron, which is subject to a rubbing action, is thus the cause of the anti-frictional properties of cast-iron, and is at the same time the cause of such disintegration as takes place.

The hard glaze which a cast-iron liner takes after a period of running is a matter of common experience. The surface of a high speed engine cylinder becomes, with length of service, increasingly difficult to file, and the raised markings left on the cylinder walls after a "seizure" has taken place are often glass hard, and cannot be filed at all. Mr. Hurst suggests that the most important cause among the many responsible for the glazing of the surface of cast-iron is that, under the alternating stresses brought about by the motion of the piston, the surface grains are deformed by being broken down along the slip planes, ultimately producing a surface of very fine crystal structure. Micro-examination of such surfaces reveals in many instances, very fine granular structures, even at high magnifications. Such surfaces are harder, and will obviously be far less sensitive to the effects of surface disintegration than the original coarser grained structure.

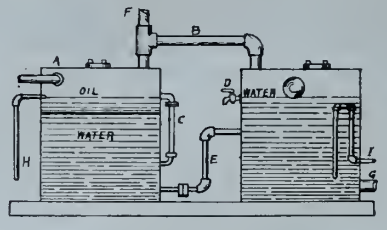
If this interpretation be correct, it provides a good theoretical justification for the practice, which it is believed some continental gas-engine makers follow, of running pistons in their cylinders for some time under the belt before putting the engine to work on load and under its own power. It would be interesting to inquire how much there is in common between the glazing phenomenon in cost-iron and the great toughening of the surface of manganese steel, which takes place under a rolling or hammering action.

AN OIL SEPARATOR

By J. E. N.

GREAT damage has been caused by allowing oil to get into steam boilers. Separators are placed upon the exhaust pipes from pumps or engines, a trap connected to the drip from the separator, and the engineer often proceeds to forget all about oil in his returns when the job is completed, with the result that the trap becomes inoperative from thick cylinder oil, and if nothing more serious happens, the result is that the boiler cleaner will find a long dirty job to be done the next time the boilers are opened for cleaning. However, it is quite possible that damage may be caused by a foaming boiler, or a burned or bagged plate is a possibility.

In the sketch shown is an idea worked out and said to give good results. Two iron tanks are secured, and the exhaust inlet enters at A. The pipe B connects



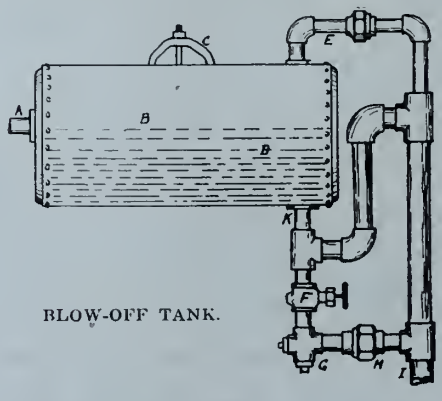
OIL SEPARATOR.

the two tanks, the branch F being open to the atmosphere. Suitable plates are bolted to the top and side of each tank, and can be removed to clean out the tanks. C is an ordinary gauge glass, which shows the depth of oil in the tank; a small quantity of water can be drawn off at D every few days to show if any oil is getting into the draw-off tank; the clean water suction is shown at G. Pipe H is the overflow oil pipe to either a receiver or the sewer. The water passes from the receiving tank to the discharging tank through the pipe E. Clean city water can be run into the tanks at any time desired through the piep I. An improvement would be made if an ordinary float operated valve was connected to the pipe I, as shown.

BLOW-OFF TANK

By John Port.

THE connections on the blow-off tank, illustrated herewith, are different from those generally used. The blow-off pipe A from the boiler is 2 in. in diameter. The outlet pipe K is 3½ in., the valve and connections at F, G and H are 2 in., also the pipe E is 2 in. At C is a clean-



BLOW-OFF TANK.

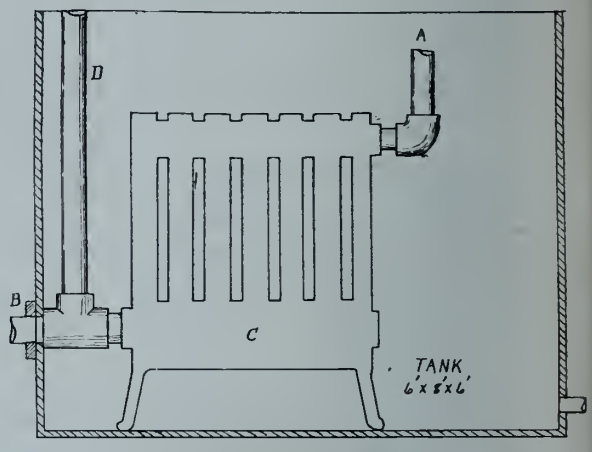
out hole. Should the trap at K become stopped up there will be an opening through E. The valve F can be opened once in a while, and the dirt, which may settle in the inlet end of the tank, washed out.

The tank should be about 30 x 60 inches. Note that the inlet pipe is just above the outlet of the trap water level. The end I runs to the sewer.

DOMESTIC WATER HEATER

By John Ellethorn.

A FACTORY which used considerable hot water for employees' meals, etc., employed a novel arrangement for heating the water. Originally they had a pipe coil along the bottom of the tank running the exhaust, from a small upright steam engine, through it. A number of small holes developed in the coil, and it had to be discarded. An old Bundy cast iron radiator, which was not in use, was connected in the open tank, as shown in sketch. The inlet was at A, and the out-



DOMESTIC WATER HEATER.

let to the hot well was through a valve at B. Sometimes the water was not as hot as required, so as an experiment the pipe D was added. This pipe extended over the top of the tank, and was connected to the outlet pipe beyond the valve at B. The idea was that some back pressure would be necessary to keep the radiator free of condensation with valve B closed, thus getting a greater number of heat units through the radiator into the water. An oil separator was attached to the exhaust, and the clean condensate returned to the hot well.

The tank was cast iron, and had a properly constructed cover. However, the manhole cover was not fastened.

The water level was regulated by a ball cock in the usual way.

The radiator was a large one, and gave excellent results.

Some Loan.—A Kerry peasant sued another for a loan. "It was a Kathleen Mavourneen loan, yer honor, an Paddy Kane knew it was at the time he gave it to me," said the defendant.

"A Kathleen Mavourneen loan?" said the puzzled judge. "What sort of a loan is that?"

"That's what we call one kind of loan, yer honor, down in our part of the country; it may be for years and it may be forever."

Question and Answer Section

Question.—I have a D.C. motor, 1-6 horse-power, 110 volts, which it is desired to use on a 220 volt circuit. What method would you suggest that it could be used and would it apply to alternating current?—J.B.

Answer. — The most satisfactory method would be to purchase a small transformer. If the motor is of the type which runs on either D.C. or A.C., it would be quite satisfactory. Otherwise it would be necessary to get another motor as the cost of rewinding, etc., for the higher voltage and different current would not be justified by circumstances.

* * *

Question.—Is there any necessity for having a damper in chimney which gives far more draft than required. The chimney is connected to a battery of boilers and there is at present a damper between the boiler and smoke box of each boiler.— F.C.

Answer.—The individual dampers at each boiler are necessary to take care of any variations in their conditions such as class of fuel, rate of working, etc., while the main damper in the chimney is required to counterbalance variations in weather conditions which affect the draft of the boilers as a whole.

* * *

Question.—What is the difference between a pop safety valve and an ordinary spring loaded valve. Are there certain conditions which make it more desirable to use a pope valve?—T. K.

Answer.—Pop safety valves are now universally used in marine work and other lines where the working pressures are high and there is little margin between the working pressure and the blow off point. They are so constructed that when slightly lifted off the seat, an additional area is exposed to the pressure of the steam, with the result that the valve is kept open until the boiler pressure has dropped well below that at which it opened. In this way the valve is not exposed to the cutting action of the steam which takes place when a valve is simply showing a feather of steam, resulting in longer life to the valve. Ordinary types of valves are more suitable for plants where the working pressure seldom approaches the blow-off point, thus acting as safety valves pure and simple and not so much as pressure regulators.

Question.—Although I have had occasional work to do in connection with ammonia refrigerating plants, I have never been in any accident where I received damage or injury by the ammonia. As I may not always be so fortunate, I often wonder just how I should act in case of accident?—R. L.

Answer.—As an operator of some experience it is presumed that you know what to do in the way of manipulating the plant, and that your inquiry relates more to method of treatment, etc. In this, as in any emergency one must be governed by circumstances. If you are overcome by the ammonia fumes your actions will be of a very limited nature, and help from another will be required. It is a good plan to have a supply of pure cider vinegar on hand, diluted to a point where you can drink it; acetic acid which is the active agent in this neutralizes the ammonia, which is not the case with ordinary commercial vinegar having sulphuric acid as a base.

In the case of a serious leak which it is required to repair, a helmet of any type as supplied for the purpose should be on hand and instantly available, failing which a number of cider-soaked sponges may be tied around the nose and mouth although these do not protect the eyes. A weak solution of boracic acid in water should be used for bathing the eyes while equal parts of raw linseed oil and lime water make a splendid dressing for flesh burns.

* * *

Question.—What is the formula for finding the horse-power of a given tangential water wheel as the water pressure is decreased or increased?—J. M.

Answer.—In order to determine the amount of power available from a given quantity of water under a given head, multiply the number of cubic feet of water per minute by the number of feet of head, and this by 62.3, which equals the weight of one cubic foot of water. Divide the result by 33,000, which equals the number of foot-pounds in one horse-power, and the result is the theoretical horse-power in the water. This should be multiplied by the percentage of efficiency, which you can take as a rule as 80, which will give the horse-power available on the water wheel shaft.

C. A. S. E. CONVENTION AND SUPPLIES EXHIBITION

THE following provisional programme has been arranged for the annual convention of the Canadian Association of Stationary Engineers and Supplies Exhibition, to be held at Toronto from July 24 to 27, inclusive. Premises have been rented at 70 King St. West. The exhibitors will occupy the ground floor, while the first floor will be used for the convention sessions. It has been decided to keep the exhibition open each day, excluding Wednesday, July 25, which has been set apart for a trip to Niagara Falls, via Lake Ontario.

Tuesday, 24th.

Convention opening by a member of the Board of Control. Smoker in the evening—boxing and music. Entertainments and outings for visiting ladies.

Wednesday, 25th.

Engineers and exhibitors' day trip to Niagara Falls, boat to Lewiston, and trolley via the Gorge route to Niagara Falls, N.Y. Lunch there and return on Canadian side by trolley, to Queenston Heights, and back to Toronto by boat.

Thursday, 26th.

At 10 a.m., annual meeting of Exhibitors' Association. C. A. S. E. sessions. In the evening there will be an automobile trip round the city and then to Scarboro Beach Park.

Friday, 27th.

Closing day. No special feature arranged as yet.

The Exhibitors' Association executive this year is as follows:—Hon. President, H. P. Stevens; Past President, H. L. Peiler; President, Earl F. Hetherington; 1st Vice-president, Lloyd Archibald; 2nd Vice-President, C. N. Schragg; Treasurer, B. G. Newton; Secretary, Gordon Keith; Asst. Secretary, L. H. Rumage; Chairman Exhibit Committee, James E. Fiddes; Entertainment Committee, A. W. Crouch; Reception Committee, H. T. Ramshaw.

CANADIAN ELECTRICAL ASSOCIATION

AT a meeting of the Managing Committee of the Canadian Electrical Association, held in Ottawa, on April 26, it was resolved that the association hold a strictly business two-day convention on June 7 and 8, in Montreal; that no fund or provision be made for the entertainment of delegates, but that arrangements be perfected for full reports from the various technical and commercial committees

of the association, these reports to be distributed in advance and discussed at the convention; that the meeting be made as practical and businesslike as possible, with a view not only of stimulating membership, but so as to be of the greatest assistance possible to those attending. In connection with the above:—

The Managing Committee feels that the time is ripe for a meeting of the above character.

Many developments have taken place in the electrical world since they have had an opportunity to discuss these matters.

No diversion is contemplated, and attendance is asked in the interest not only of one's own affairs, but also of the industry at large.

The National Electric Light Association has given up the idea of its usual type of convention for this year.

Under the circumstances, the association is not making any special arrangement either for accommodation or transportation. These are matters which each delegate will settle for himself.

Place of meeting will be the Ritz-Carlton Hotel, and arrangements will be made so that, on the evening of June 7, all may dine together at a set rate for each person.

GRAND LODGE, C. A. S. E. INCORPORATION

AN Act to incorporate the Grand Lodge of the Canadian Association of Stationary Engineers which has been before the Federal Government at Ottawa, is now effective, passage of the articles of incorporation having received the consent of both the House of Commons and the Senate. . Needless to say with completion of the procedure involved, an added stability, enlarged scope, and therefore greater degree of usefulness may be expected to mark the future activities of the association. The Articles of Incorporation follow:—

Whereas the persons hereinafter named have by their petition prayed that it be enacted as hereinafter set forth, and it is expedient to grant the prayer of the said petition: Therefore, His Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:—

1. Robert Dyson, of the city of Guelph; John Hale and Alfred W. Heath, both of the city of Hamilton; Rodger F. Gofton, of the city of Kitchener; William Cooke, of the city of Belleville; John W. Beasley, of the city of Chatham, all in the Province of Ontario; and William G. Forbes, of the city of Montreal, in the Province of Quebec, practising stationary engineers, together with such other persons as may become members of the association, are hereby incorporated under the name of "The Grand Lodge of the Canadian Association of Stationary Engineers of the Dominion of Canada," hereinafter caller "the Association."

2. The persons names in section one of this Act shall be the executive officers of the Association and shall hold office until their successors are elected.

3. The head office of the Association shall be in the city of Hamilton, in the Province of Ontario.

4. The affairs and business of the Association shall be managed by a representative body to be known as "The Grand Lodge," consisting of not less than seven nor more than fifteen members, who shall be elected annually in such manner as is determined by by-law of the Association.

5. The executive officers, and such officers as are designated by the by-laws of the Association, shall be elected from delegates to Grand Lodge convention.

6. Subject to the constitution and by-laws of the Association, branches under the name of "Lodges," subordinate to the Grand Lodge of the Association, may be established in Canada under the title or number designated in the charter granted by the Grand Lodge of the Association when constituting such branches with such powers as the Association may determine by by-law: Provided, however, that such powers shall not be in excess of those conferred on the Association by this Act.

7. The Association may make such rules and by-laws for the government and management of its business and affairs and for the guidance of its officers and members, and especially with respect to the qualification, classification, admission and expulsion of members, the fees and dues which it may deem advisable to impose, the control and management of its funds, the number of members composing the Grand Lodge, and the number, constitution, powers and duties of an executive committee, board of trustees or managing committee, and of its officers, and generally for regulating every matter, and thing proper and necessary to be done for the good of the Association and for the carrying out of the objects and purposes of this Act.

8. The objects and purposes of the Association shall be to promote by all lawful means the efficient operation of steam and electric power plants, and for the said purposes:

(a) To serve as a school of instruction for its members;

(b) To hold meetings for discussing theoretical and practical matters pertaining to its calling;

(c) To examine stationary engineers and firemen as to their proficiency, and to grant graded certificates of ability to its members, and to be a medium through which steam and electric users may be supplied with good and reliable engineers, and to grant relief to its members in cases of sickness and distress.

9. All members in good standing of existing institutes incorporated under provincial Acts, and of associations who apply for membership after the passing of this Act, and other persons of whose qualifications and fitness the Association approves, shall be eligible for membership in the Association.

10. The first general meeting of the Association shall be held during the year 1917, at such time and place and upon such notice as the executive officers of the Association may decide. Subsequent general meetings shall be held annually as the by-laws of the Association may provide.

11. At any general or special meeting, members may be represented and vote by proxy, but no such proxy shall be exercised by a person who is not a member of the Association and in good standing.

12. The Association may affiliate with any association or corporation having the same or similar objects.

13. Subject to provincial laws, the Association or any branch thereof may acquire by devise, bequest, purchase, gift or lease, real property, not exceeding in the aggregate of one hundred thousand dollars, and may sell, mortgage, lease or dispose thereof, but so that the Association shall apply all its profits,if any, or their income, in promoting its objects, and shall not at any time pay any dividends to its members; but the provisions of this section shall not prevent the remuneration of members of the Board of Directors, or officers of the Association for services rendered out of any surplus remaining after the ordinary expenses of the Association have been met. The Association shall, within ten years after its acquisition of any real estate, sell or otherwise dispose of and alienate so much thereof as is not required for the use and occupation of the Association.

14. If any subordinate lodge or member of the Association ceases for any cause whatever to be a member of the Association, it or he shall not, nor shall its or his representative have any claim against the funds and property of the Association.

15. The Association shall acquire and take over all existing business and rights held and enjoyed by and be subject to all the obligations and liabilities of the Canadian Association of Stationary Engineers, incorporated under the provisions of the Revised Statutes of Ontario, 1877, chapter one hundred and sixty-seven, An Act respecting Benevolent, Provident, and other Societies, and except in so far as it may be necessary for the purposes of such transfer, the powers and authority vested in the Association under the provisions of this Act shall not be exercised or become effective until all the business and rights held and enjoyed by the said the Canadian Association of Stationary Engineers have been transferred to the Association and evidence of such transfer satisfactory to the Secretary of State of Canada has been filed with the said Secretary of State.

First Guest (at reception)—Have you a speaking acquaintance with that lady in black?

Second Guest—No; I have a listening acquaintance with her. She has a speak-acquaintance with me.

First Guest—I don't understand.

Second Guest.—She's my wife.

OIL SEPARATORS—II

As pointed out in the previous article, gravity, impact and change of direction are employed either singly or collectively in all mechanical devices for separating oil and moisture from steam. The manner in which these

FIG. 7. "BUNDY" OIL SEPARATOR SHOWING METHOD OF REMOVING PLATES.

features are combined varies with the conditions under which the separator is to be used.

Bundy Separator

This separator is of the baffle type and employs a series of separating plates, one of which is shown in course of withdrawal in Fig. 7. Each integral column of the plate has a channel or direct cut through its centre, communicating with the cups or sub channels which are bored through from the front of the plate, and which are set to fall against the direction of the steam travel. The columns of the separator plates are arranged in staggered formation so that the steam in passing through the open space between the columns in any plate, will impinge upon a column in the succeeding plate.

All steam, therefore, in passing through the nest of plates must touch more than one; consequently the particles of oil and water, suspended in the steam, cling to the surfaces of the cast iron columns against which they are projected, collect in the anterior cups, enter the interior channel and fall into the receiver below. The flanges at the bottom of the plates, "make up" close, and prevent any portion of the water or oil being picked up by the steam and carried forward. As shown in the illustration, all of the plates can be removed from this separator for the purpose of cleaning without breaking any pipe connections. It is desirable to do this at intervals as the more solid particles of the oil adhere to the filter plates and do not drain freely to the well, A thorough boiling in potash or soda solution for several hours removes all traces of the most stubborn deposits.

This separator is built by the Canadian Griscom-Russell Co., Montreal, who also build the Stratton Jr. oil separator, a type which is well adapted for handling steam at high velocities.

Stratton Jr. Separator

This apparatus is specially designed to provide means of condensing the volatile gas in which form much of the oil is carried over from the steam cylinder. The method adopted is to cause the entering steam to pass through a curtain of water thrown entirely across the throat of the separator by a spray nozzle located in the centre of the inlet steam passage. This spray forms a zone across the pipe in which the temperature is reduced, thereby condensing the oil gas which is in very unstable equilibrium; and as this condensing action occurs in contact with water, the oil gas, as it condenses, collects around the individual particles of spray water, which, coming in contact with the liquid oil in the steam completes the process of oil collection. The resultant oil-covered drops of water are then carried by the current of steam into the body of the separator which is

FIG. 8. "NATIONAL" OIL SEPARATOR SHOWING INTERNAL RIBBED BAFFLE WITH SUPPLEMENTARY PORTS.

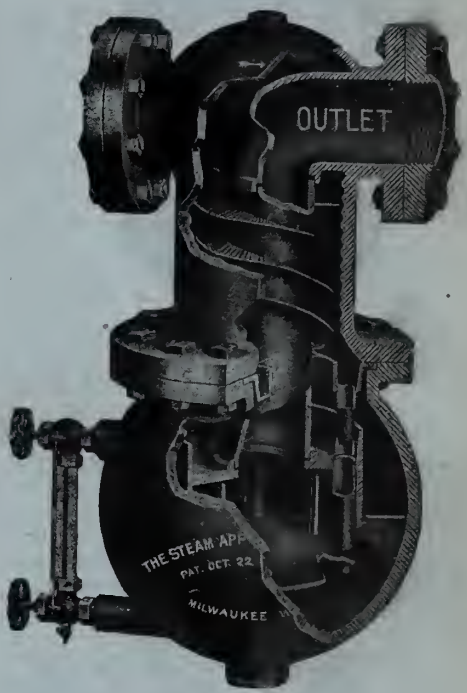


FIG. 9. SECTIONAL VIEW OF "TRIUMPH" OIL SEPARATOR. NOTE SPIRAL PASSAGE AND DRAIN TUBES

constructed on the centrifugal principle. Here the oily moisture is thrown to the walls of apparatus and effectively separated from the steam which leaves the separator through a central vertical pipe amply distant from the water and oil in the receiver space below.

National Separator

This device is of the horizontal type, see Fig. 8, and embodies all of the effective principles, both as to design and construction that insure separation of oil from exhaust steam. Gravity impact and change of direction are all employed to eliminate the oil from the steam, and properly disposed baffles prevent it being picked up and carried along.

The internal area of this separator is unsually large, thus allowing the velocity of the incoming steam to be reduced to a point where the heavier particles of foreign matter fall out of the current by gravity. Minute particles carried in the current of steam, impinge on a main baffle which extends the full width of the separator and has vertical ribs to pre-

vent side travel. Through this baffle is a series of ports or holes each of which is provided with an individual baffle so disposed that the steam must make a further change in direction in order to pass through. The lower part of the

FIG. 10. "VICTOR" OIL SEPARATOR WITH ALTERNATE VERTICAL GROOVED BAFFLES.

separator forms a storage chamber from which a large drip opening allows drainage to be removed.

This apparatus is a product of the National Pipe Bending Co., Newhaven, Conn., and is built in regular sizes from 3 in. to 24 in.

Triumph Separator

This separator, along with the Victor which follows, is built by the Steam Appliance Co., Milwaukee, and makes prominent use of the centrifugal principle. The entering steam is led downward by a series of spiral baffles which cause the oil and heavy particles of entrained moisture to be thrown outward against the walls of the body. These walls are corrugated to assist in the

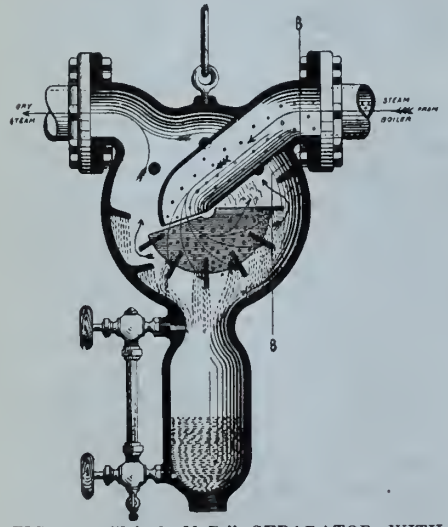


FIG. 11. "W & McD." SEPARATOR WITH RADIAL BAFFLES.

deposition of the oil particles, and the spiral baffles do not touch the walls, so that collected matter drains down into an annular catch basin or trough from which they are conveyed to the bottom of the receiving space. The steam makes its exit through a central vertical pipe to the outlet as shown in illustration, Fig. 9.

Victor Separator

A curved corrugated baffle is the feature of this separator which is of the horizontal type and adapted for use either as a steam or oil separator. Sectional view, Fig. 10, shows the disposition of the curved baffle opposite the inlet on the right, which is followed by two succeeding straight baffles on either side. The entering steam is effectively broken up by the curved baffle, the entrained oil and moisture being precipitated, after which the steam passes around the outer ends and impinges on the straight baffles shown. The lower portion of the vessel has ample capacity as a storage chamber.

W. & McD. Separator

The horizontal type of separator shown in Fig. 11 is built by Watson & McDaniel Co., Philadelphia, and combines reduced velocity with change of direction. Several plates are disposed radially around the inner end of the inlet pipe so as to offer little if any resistance to the passage of steam, while their surfaces are such that oil deposited thereon is gradually washed over by the action of the steam and finally drops clear of the current into receiver.

ascending or descending currents the separating elements being arranged certically with the drainage space toward the left for connection to grease trap. An access door on the side permits withdrawal of the plates for cleaning. The horizontal type has the plates so arranged that they can be taken out as a

FIG. 13. HORIZONTAL "SWARTWOUT" OIL SEPARATOR EMBODYING HELICO-CENTRIFUGAL PRINCIPLE OF OPERATION.

unit by removing the lower part of the casting which forms the receiver space. The curved shape of the baffle plates is clearly shown, also retaining springs

FIG. 12.
LEFT.—VERTICAL TYPE WARREN OIL SEPARATOR.
RIGHT.—HORIZONTAL TYPE OF SAME APPARATUS.

Webster Separator

Two types of this oil separator are shown in Fig. 12, that to the left being the vertical design, and that to the right the horizontal. These separators are equipped with steel multi-baffles, formed of a number of hooked steel plates interposed to the flow of the steam, causing separation by impact, by change of direction, and by adhesion. There is no unobstructed path through any of these oil separators, yet the free area through which steam must pass is several times greater than the area of the connections thus minimizing pressure loss due to friction.

The vertical type is suited for either

above which hold the unit in place. Darling Brothers, Montreal, build and market the various sizes of this apparatus.

Swartwout Separator

These oil separators are of the helico-centrifugal type relying entirely upon the correct application of centrifugal force to obtain the desired separation of oil particles from the steam. Where proper lubrication is employed, the oil is never evaporated at ordinary steam pressures, but is merely mechanically mixed with exhaust steam and hence is readily susceptible to the influence of centrifugal force. Figs. 13 illustrates the horizontal type of this device. A helix

of twisted plate is inserted in the inlet passage in such a way that the mixture of steam and oil is caused to travel around the passage, causing centrifugal force to come into play, the full effect of which is obtained when the steam reaches the enlarged portion of the casting. Here the particles of oil and associated water are thrown far beyond the limit of the moving column of steam which because of its excessive lightness is scarcely affected by centrifugal force.

The steam passes out through an opening with a tubular extension which prevents the separated particles from escaping with the steam. Ample capacity is provided in the reservoir for separated matter. The Ohio Blower Co., Cleveland, O., are the builders of this separation which is made in a full range of sizes from 1½ in. to 40 in.

LIFT AND FORCE PUMPS

IT is a well-known fact that, under the class of pumps styled "the lift and force type," are included those of the bucket-and-plunger class, but it is not so generally remembered that a bucket-and-plunger pump is double-acting. If one examines a bucket-and-plunger pump, it will be seen that it is a combination of a bucket pump and a plunger (or ram) pump. In general terms the diameter of the ram (of plunger) should be one-half of the area of the bucket attached to the end of the ram. Its action is as follows:—

When the bucket is raised, a column of water equal to the bucket displacement follows it, the length of such column being precisely equal to the length of the stroke of the pump. At the return stroke, and when the bucket is progressing downwards, i.e., towards the foot valve fixed in the body or chamber of the pump, the water passes through the combined area of the passages through the bucket, lifts the bucket valve (or valves), and accumulates above the bucket. Now, the ram, being one-half of the area of the bucket, leaves an annular space around the ram equal to half of the area of the entire area below the bucket. So it follows that half of the quantity of the water that has passed the foot valve, and has passed through the valves of the bucket, is raised up the main, the other remaining in the barrel above the bucket. When the bucket again moves upward, the remaining half of the water belonging to that particular stroke (or cycle) is lifted into the delivery main. From this it will be clearly understood that half of the quantity of water is delivered to the main on the up stroke and a half on the down stroke. Consequently the pump is purely double-acting, but delivers only the same quantity of water per full cycle, or stroke, as a single-acting pump of the same diameter of barrel .

In designing such a pump, careful note should be made that the passages through the bucket are of ample area, the webs of the bucket as thin as reasonably possible, and well tapered, and having the thinnest edge of the webs towards the foot valve. The junction between the plunger and the bucket should be so designed that ample water way is given for the passage of the water through the bucket valve, the orthodox and accepted means of accomplishing this being the well tapering of the bottom end of the plunger where it joins the bucket.—Practical Engineer.

GRAPHITE LUBRICATION FOR CYLINDERS

By M. Meredith.

THERE are many purposes for which exhaust steam could be used with very great advantage were it not for the lubricating oil which becomes suspended in it as it passes through the cylinder. Many attempts have been made to find an alternative lubricant to oil which, while answering the same primary purpose, will be free from its many disadvantages. Naturally, attention has been turned to graphite, which has been proved to have excellent lubricating qualities for many kinds of work. Pure graphite, in the finest powder form, has for many years been available, and there have not been lacking efforts to use it for cylinder lubrication; but with little success, for it was soon found that the graphite was apt to accumulate behind the piston rings, in the ports and pipeways, and even in the condensers, to such a degree that the working parts became clogged and the passages choked. For these reasons the attempt to use powder graphite for cylinders was abandoned.

Late in 1906, however, Dr. Acheson, in the United States, discovered the "deflocculation" process, whereby the particles of graphite in its powder form, already fine enough to pass through a sieve having 40,000 meshes per square inch, are further broken down so that each particle is subdivided into about 1,000 parts. These particles are so small that they will pass through the finest chemical filter paper almost as readily as pure water, and are too fine even to be rendered visible by a sunbeam when floating in air.

E. W. Johnston recently gave an account of the successful use of this ultra-fine form of graphite for cylinder lubrication to the Birmingham Association of Mechanical Engineers. Searching some six years ago for some means of economically overcoming the difficulty of oil contamination in the feed water, and particularly in the exhaust steam, he determined to try the deflocculated graphite. Having overcome the difficulty of securing a continuous and adjustable sight-feed by using a U shaped sight tube filled with paraffin instead of water, placing the feed nozzle at the top instead of the bottom, and passing the water-borne lubricant into the current of steam he applied the graphite to the cylinders of three 50 kw. high speed dynamo engines, two deep borehole pumping engines, and certain other steam pumps operating on saturated steam at 120 lbs. pressure. No trouble was experienced and the usual three weekly inspections of cylinders showed that the general impression of efficient lubrication was well founded.

One of the high-speed engines, after accurate gauging of the valves and cylinders, was put on a six months' running test. At the end of this period the greatest wear at any point was found not to exceed one-thousandth of an inch, and it was particularly noticed that the walls of the high-pressure cylinder and piston rings were in faultless condition, having mirror-like surfaces. The implication was that the graphite lubricant had formed a real graphite coating on the rubbing surfaces, espcially as, in certain cylinders composed of more open-grained iron, the graphite had evened-up the minute depressions. Since uniformly satisfactory results were obtained also on the pumping engines and other auxiliaries, the use of oil was abandoned, and for the last five years the entire plant has been worked on this fine graphite as the sole cylinder lubricant, with the result that all available condensed steam can now be returned to the boilers, and 10 per cent. only of make-up water is added daily. The boilers are free from grease and entirely free from suspicion of "pitting," and a feed water of considerably higher temperature and exceptional purity is available, resulting in further fuel economy. Mr. Johnston makes it plain that his experience has only been in connection with engines running on non-superheated steam, as to the results that might be derived when operating with superheated steam, he is not in a position to express an opinion.

THE EFFECT OF STORAGE ON COAL

By S. D.

IT IS a matter of obvious and common knowledge that if stored coal be allowed to generate spontaneous heat its calorific value will suffer heavily, and for that reason storage under water has been from time to time advocated and practised; but there is also a widespread assumption that apart from spontaneous heating coal stored in the open deteriorates sensibly in the course of a year or two as a result of disintegration accompanied by chemical loss. Tests carried out over the last five years point to the entire fallaciousness of that belief, so far at any rate as the gas-making properties of coal are concerned.

A truck load of each of two grades of gas coal were set aside five years ago for the purpose of the experiment. The coal was stored in the open, in bins nine feet deep, provided with separate compartments, and each succeeding year a compartment was cleared and the coal tested in 400 lb. retorts. The results fluctuated somewhat from year to year, but after allowing for certain variables in the working of the retorts, the conclusion was arrived at that no deterioration in the gas-making quality of the coal had taken place even at the end of the fifth year.

The main body of the coal suffered little physical change during the five years. The top six inches had crumbled considerably but even in this top six inches chemical analysis failed to reveal any material change, even after five years' weathering.

Progress in New Equipment

AUTOMATIC TEMPERATURE CONTROL

THE demand for automatic apparatus wherever applicable has led to the development of automatic temperature controllers for gas and oil-fired and electrically-heated furnaces, a comprehensive line of these devices being now manufactured by the Bristol Co., Waterbury, Conn.

The principle on which these new devices are designed is to employ three elements—the measuring element, the contracting element, and the operating element.

The measuring element consists of various types of Bristol electric pyrometers and thermometers. The controlling element is combined with the measuring element, and consists primarily of an electrical contact closing device, which operates at predetermined high and low temperatures, thus closing or opening electrical circuits which energize or disconnect the operating element. The interior of the controlling element is shown in Fig. 1, from which it will be seen that the indicating arm is completely insulated from the operating circuits, the contacting device being frictionless. These controllers are furnished for all temperatures up to 3,000 deg. F., with high resistance movements for use either with base or rare metal couples.

The operating element consists of the device which actually regulates the heat supply in the furnace; as, for instance, in the case of a gas-fired furnace, a pair of electrically-operated gas and air valves, and in the case of an electric furnace, it consists of a special relay switch opening and closing the circuits of the heating element of the furnace.

FIG. 2—INTERIOR VIEW OF VAPOR TYPE THERMOMETER-THERMOSTAT.

An interior view of a vapor-type thermometer-thermostat is given in Fig. 2, complete with sensitive bulb, this type of instrument being adapted for use with a special relay switch, which is used when these instruments are employed for controlling temperatures in electric ovens and furnaces. The special design of contact closing device shown has proven very practicable and durable in long continued service. Both high and low contacts are shown in this illustration, but when used with the maker's automatic electrical controlling valves for both gas and air supply only one contact is required.

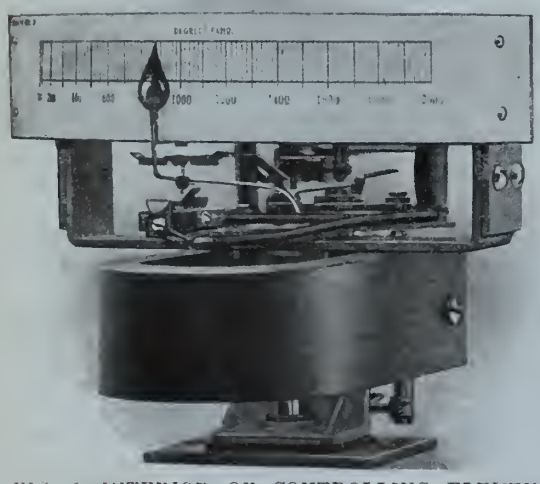


FIG. 1—INTERIOR OF CONTROLLING ELEMENT.

ANTI-ACID VALVES

THE Lunkenheimer Co., of Cincinnati, Ohio, state that during the past year there was an exceptionally good demand for valves made entirely of iron for use in handling cyanides and other solutions which attack metals having copper as their basic element, and which consequently could not be handled by brass valves or valves having any part made of brass. This company, we understand, have supplied a large number for use in dye and chemical manufacturing plants, but the demand was not confined to these sources, as quite a number were also supplied for use in mines, oil refineries, tanneries, pulp and chemical fibre mills, canning and packing establishments, etc. In the manufacture of these all-iron valves, a composition is used that is claimed to be exceptionally free from impurities, resulting in solidity of grain structure which insures great strength and makes the castings more resistent to corrosion and chemical attack. For handling the more severe solutions, such as caustic soda, caustic potash, soda-ash, and other similar alkaline liquids, the company employ a composition known as "Lunkenheimer Nickel-iron." The exceptional acid resisting qualities of this metal and the long and satisfactory service rendered has led many to use valves made of this material even for the weaker solutions. The standard line of Lunkenheimer All Iron Valves includes "Ferrenewo" Globe, Angle, Cross, and Check Valves in sizes as small as ¼-in., and up to 2 inches; cross valves, sizes 2 to 12 inches, inclusive; "Clip" gate valves, as small as ½ inch and up to 6 inches; "Victor" gate valves, sizes 2 to 12 inches, inclusive; quick opening gate valves with lever, sizes ½ to 12 inches, inclusive ,and check valves up to 12 inches inclusive.

Spon's Electrical Pocket Book. By Walter H. Molesworth. 488 pages 6¾ x 4¼ ins., 325 illustrations. Published by E. & F. N. Spon Ltd., London and Spon and Chamberlain, New York City. Price $1.75 net. This is a new reference book of general electrical information, formulae and tables for practical engineers. The book contains a great deal of useful information for electrical engineers arranged in compact form and written in a clear and concise manner. Some sections, namely, thosedevoted to essentially English practice such as British Board of Trade and Home Office Regulations, etc., will not be of much practical value in Canada, but as it is an English publication this feature could not be eliminated. It is however an excellent handbook and in all other respects will be a valuable reference book for engineers in almost any country. Being a pocket book, questions relating to design and detail have not been included, nor has space permitted of reference to telegraphy, telephoning and special branches of electricity.

TWIN FILTERS

With a Twin Filter there is no need of by-passing the water at any time, as there is always one filtering chamber in service.

The Twin Filter

Two separate filtering chambers each containing a filtering unit, which may be cleaned and replaced any time without interfering with the other. No interruption in service—no shut down or by-pass necessary while cleaning.

Safety demands all your feed water to be filtered to remove the oil, dirt, rust, etc., contained therein —it is a "safety first" policy. Impurities, especially oil, accumulate on the boiler tubes and increase the danger of boiler explosions.

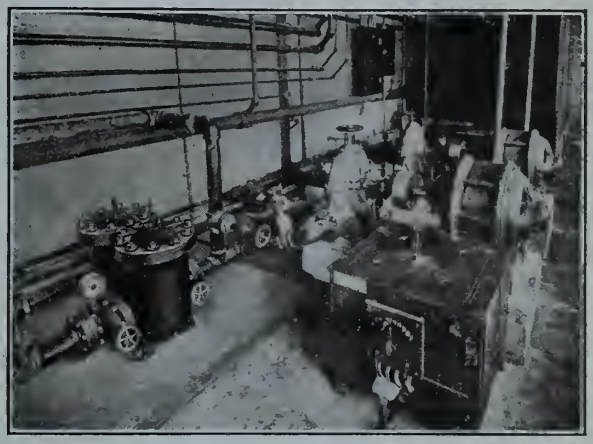
The same "safety first" policy should be followed with all your service water for it is easier to keep the sediment, etc., out of your apparatus than it is to remove it after it gets in—to say nothing of the wear and tear on the apparatus.

Mr. A. C. Ruhl, Chief Engineer for the American Gypsum Co., Port Clinton, Ohio, writes us in part under date of Aug. 16th, 1916, as follows:—"- - - I think if it were not for the Grease Extractor we would shoot our condensate into the river as there is too much oil going by the Oil Separator, especially on heavy load and high vacuum, but the Grease Extractor in the boiler feed line is there as a 'safety first', keeping our boilers free from oil.- - - "

Complete information about the Twin Filter and Grease Extractor in Bulletin "B." Send for a copy.

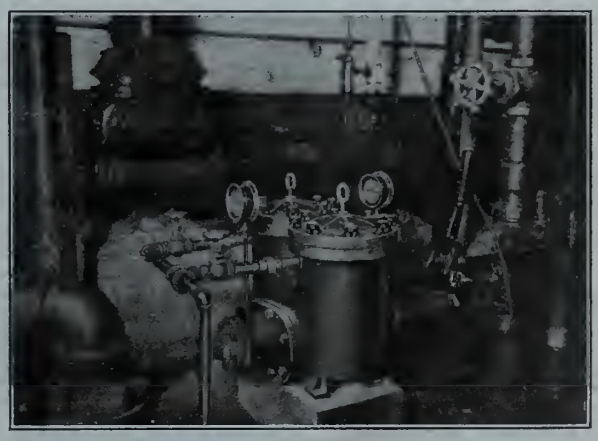
Elliott Company

6902 Susquehanna Street
Pittsburgh, Pa.



The Twin Filter shown above insures a continuous supply of clean water for the step bearings of the turbines in a large hydro-electric plant.

The Twin Filter shown above protects the coils of water-cooled transformers from being clogged up or coated with sand, sediment, etc.



The Twin Grease Extractor shown above insures an uninterrupted supply of boiler feed water, free from oil and grease, for a 5,600 h.p. battery of boilers.

If any advertisement interests you, tear it out now and place with letters to be answered.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$27 00	$.....
1¼ in.	33 00	.....
1½ in.	35 00	30 00
1¾ in.	36 00	30 00
2 in.	38 00	30 00
2½ in.	46 00	36 00
3 in.	52 00	42 00
3¼ in.	.....	48 00
3½ in.	52 00	52 00
4 in.	76 00	65 00

Prices per 100 feet, Montreal and Toronto

BOILER PLATES.

	Montreal	Toronto
Plates, ¼ to ½	$9 00	$8 00
Heads	9 30	8 10
Tank plates, 3-16 in.	9 10	8 10

WROUGHT PIPE

Effective May 14, 1917

Size	Black Per 100 feet	Galvanized Per 100 feet
Standard Buttweld		
⅛ in.	$ 4 50	$ 6 00
¼ in.	4 96	7 00
⅜ in.	4 96	7 00
½ in.	6 29	7 86
¾ in.	7 94	10 06
1 in.	11 73	14 88
1¼ in.	15 87	20 13
1½ in.	18 98	24 06
2 in	25 53	32 38
2½ in.	40 95	51 77
3 in.	53 55	67 70
3½ in.	66 24	83 26
4 in.	78 48	98 65
Standard Lapweld		
2 in.	28 49	34 97
2½ in.	42 71	52 94
3 in.	65 85	69 23
3½ in.	68 08	86 02
4 in.	80 66	101 90
4½ in.	93 98	118 70
5 in.	109 50	138 40
6 in.	142 10	179 50
7 in.	185 60	232 05
8 L in.	195 00	243 75
8 in.	224 60	280 80
9 in.	269 10	336 38
10 L in.	249 60	312 00
10 in.	321 40	401 70

WROUGHT NIPPLES.

4" and under, 60%.

4½" and larger, 55%.

4" and under, running thread, 40%.

Standard couplings, 4" and under, 50%.

4½" and larger, 30%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 10%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 45; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 50%

Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	4 75
Steel bars, base, Toronto	5 00
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	4 75
Steel bars, base, Montreal	5 00
Reinforcing bars, base	5 10

SHEETS.

	Montreal	Toronto
Sheets, Black, No. 28	$7 75	$8 10
Sheets, Black, No. 10	7 50	7 90
Canada plates, dull, 52 sheets	7 00	7 00
Canada plates, all bright	8 00	8 00
Apollo brand, 10¾ oz. galvanized	7 25	7 25
Queen's Head, 28 B. W. G.	7 75	7 75
Fleur-de-Lis, 28 B.W.G.	7 45	7 35
Gorbal's Best, No. 28.	8 25	7 50
Colborne Crown, No. 28	8 00	6 75
Premier, No. 28 U.S.	8 30	8 70
Premier, 10¾ oz.	8 60	9 00

PROOF COIL CHAIN

B	
¼ in.	$9 75
5-16 in.	9 40
⅜ in.	8 65
7-16 in.	7 45
½ in.	7 25
9-16 in.	7 25
⅝ in.	7 15
¾ in.	7 05
⅞ in.	7 00
I inch	6 90
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	55
Kearney & Foot, Arcade	55
J. Barton Smith, Eagle	55
McClelland, Globe	55
Whitman & Barnes	55
Black Diamond	45
Delta Files	40
Nicholson	45
Globe	55
Vulcan	55
Disston	55

OILS AND COMPOUNDS

Castor oil, per lb.	27
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal.	20½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	6 15
Lard oil, per gal.	1 45
Union thread cutting oil antiseptic	68
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	11¼

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 50
Leather in sides	1 35

COAL AND COKE.

Solvay Foundry Coke	$10 90
Connelsville Foundry Coke	....
Steam lump coal	8 50
Best Slack	8 05

Net ton f.o.b. Toronto

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	30
Stove bolts	55
Plate washers	10
Machine bolts, 7-16 and over	10
Machine bolts, ⅜ and less	20
Blank bolts	10
Bolt ends	10
Machine screws, fl and rd. hd., steel	27½
Machine screws, o. and fil. hd. steel	10
Machine screws, fl. and rd. hd., hrass	add 20
Machine screws, o. and fil. hd., brass	add 25
Nuts, square, up to 1",	net list
Nuts, hex., up to 1",	net list
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	17½
Boiler rivets, base ¾" and larger	$6 65
Structural rivets, as above	6 55
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS

Solder, strictly	$0 36
Solder, guaranteed	0 39
Babbitt metals	14 to 60
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	4 00
White lead, pure, cwt.	16 03
Red dry lead, 100-lb kegs, per cwt.	13 87
Glue, English	0 38
Tarred slater's paper, roll	0 95
Gasoline, per gal., bulk	0 31½
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	0 69
Linseed oil, raw, single bbls.	1 40
Linseed oil, boiled, single bbls.	1 43
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	9 00
Packing, square braided	0 32
Packing, No. 1 Italian	0 38
Packing, No. 2 Italian	0 30
Lead wool, per lb.	0 15
Pure Manila rope	0 33½
Transmission rope, Manila	0 43½
Drilling cables, Manila	0 38½

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2"	$55 00	$53 00
Plain sheets, 14 oz., 14x28 in., 14x60 in.	55 00	53 50
Copper sheet, tinned, 14x60, 14 oz.	60 00	54 25
Copper sheet, planished, 14x60 base	64 00	60 00
Braziers', in sheets, 6x4 base	55 00	52 00

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 55
Brass sheets 8" wide, 20 oz.	0 60
Brass tubing, seamless	0 57
Copper tubing, seamless	0 58

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto 25%

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White Cents per lb	
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	35
Sq. & Hex., Head Cap Screws	30
Rd. & Fil Head Cap Screws	10
Flat ⅞ But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	35
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	30
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillet	10
Planer head bolts, with fillet	10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts	add 40, 10
Cold pressed nuts to 1½ in.	add $4 50
Cold pressed nuts over 1½ in.	add 7 00

METALS

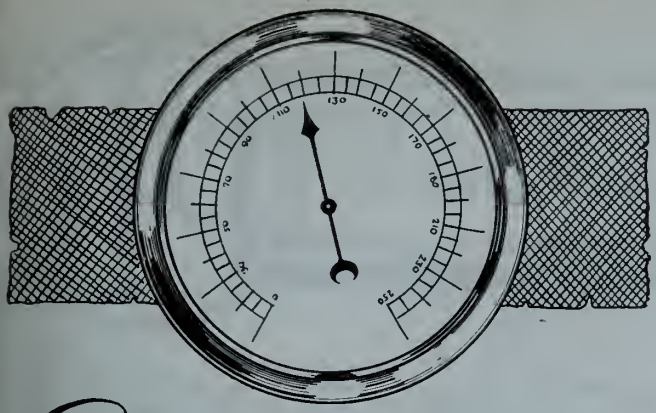
	Montreal	Toronto
Lake copper	$38 50	$37 00
Electro copper	38 50	37 00
Castings, copper	37 50	36 00
Tin	63 50	68 00
Spelter	13 50	12 00
Lead	13 00	13 25
Antimony	27 00	30 00
Aluminum	70 00	68 00

Prices per 100 lbs.

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$17 00	$17 00
Sheets, 3½ lbs. sq. ft.	17 00	17 00
Sheets, 4 to 6 lbs., sq. ft.	16 50	16 50

Cut sheets, ½c per lb. extra.
Cuts sheets to size, 1c per lb. extra.



Can you keep the pointer where it belongs?

It's getting near four o'clock. The demand for power is a trifle heavier than usual. The peak is coming. The sockets click one after another in a steady stream. The demand for steam is going up, up, up. Can You Keep The Pointer Where It Belongs?

Sturtevant
(TRADE-MARK)

Turbo-Undergrate Blower

will keep steam up. It supplies all the draft you want and just when you want it.

When you buy a blower be sure it's a Sturtevant. The Sturtevant name is a guarantee of mechanical excellence—a guarantee that you will have no breakdown and no bearing trouble.

The Sturtevant Set has generous bearings with oil rings and large reservoirs. One filling will last for weeks

To prevent the escape of steam from the casing there is a floating stuffing box. If for any reason through neglect or carelessness this is allowed to leak, there is a special "water-throw" collar which makes it impossible for steam to enter the bearings. Furthermore, the floating stuffing box makes it possible to exhaust against back pressures as high as 25 pounds.

If you have trouble getting enough steam or keeping the needle where it belongs, write us for bulletin No. 214-U.

B. F. STURTEVANT COMPANY OF CANADA, LIMITED

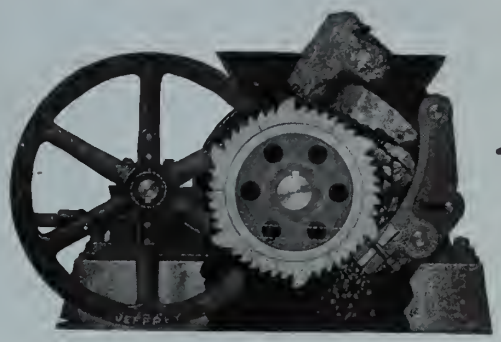
GALT, ONTARIO

Montreal Toronto Winnipeg Vancouver

Selling Agents Sanford Riley Stoker Co., Limited

"THE RILEY STOKER"

One Operation Reduces large Lumps and Run-of-Mine Coal to the Proper Size for Greatest Stoker Efficiency



JEFFREY
SINGLE ROLL
CRUSHERS

are daily proving their worth for:

The Bethlehem Steel Co.
The American Steel & Wire Co.
The International Harvester Co.
The Anaconda Copper Mining Co.

and in scores of Power and Gas Plants, Railroads and Mining Industries.

In every detail of this rugged, high-class machine you are buying the results of years of experience in a wide field of actual service.

Special Features:

1. **It is Easily Adjusted for a Large Range of Sizes and Capacities.**
2. **Consumes but Little Power. Costs Little to Install.**
3. **It can be Started-up under Full Load. It does not require a Feeder.**
4. **Occupies Small Space in proportion to its capacity.**
5. **All Joints are Machined. Gears are of Steel with Cut Teeth.**
6. **It is Provided with an Efficient Safety Device which protects against ordinary shock and accident.**

Bulletin No. 141-4 Contains a Detailed Description of this Machine—with Testimonials and Illustrations of Many Installations. Send for YOUR Copy.

The Jeffrey Manufacturing Co,

Canadian Branch and Warerooms: Montreal

(5-17-17)

Projects and Developments

B. E. Michel has been appointed city engineer of Kitchener, Ont., at a salary of $1,800.

F. Tissington has resigned from the position of chief engineer of MacKinnon Holmes & Co., Sherbrooke, Que.

Stratford, Ont.—The Public Utilities Commission has decided to purchase a number of fire hydrants for better fire protection.

Trail, B.C.—A by-law will be submitted to the ratepayers on May 22 to raise $80,000 for extensions to the waterworks plant.

The Chapman Valve Mfg. Co., Toronto, have been awarded a contract for 24-inch valves for Price Bros., paper mill at Shipsaw Falls, Que.

Swift Current, Sask.—The Local Government Board has given permission for the issue of $55,000 debentures for the purchase of a Diesel oil engine.

Three Rivers, Que.—The City Council are receiving bids on four turbine pumps, each having a capacity of between 2½ and 3 million gallons per day.

T. M. Jones, of Canadian Allis-Chalmers, Ltd., has joined the staff of the Bawden Machine Co., Toronto, as chief engineer and general manager.

Davidson, Sask.—A by-law will be submitted to the ratepayers on May 21 to raise $8,000 for the construction of a new school and $4,500 for power house improvements.

Aylmer, Ont., proposes to spend $7,000 for the installation of electrically driven pumps for its waterworks system and a gasoline pump for fire purposes.

Three Rivers, Que.—The St. Maurice Lumber Co., propose to erect a power house for six units of 10,500 h.p. and a concrete dam 1,080 feet long. R. F. Grant is manager.

The Bawden Pump Co., Toronto, have been awarded a contract for nine pumps, ranging from half-million to three-million gallons' capacity per day, by the Colonial Pulp & Paper Co., Vancouver, B.C.

Hamilton, Ont.—The Board of Control has decided to install a refrigerating plant, the cost not to exceed $6240, in the new mountain hospital. This was the amount of a tender made by the Canadian Ice Machine Co. of Toronto.

C. N. Schrag, sales engineer of the Ontario District Office of Canadian Allis-Chalmers, Ltd., has resigned to become general sales manager of the Bawden Machine Co., Sterling Road, Toronto.

T. S. Downham is again actively connected as manager with the Canadian Steam Boiler & Equipment Co., Toronto, after a holiday of several months duration. Mr. Downham has fully recovered his health.

Hamilton, Ont.—City Engineer Gray reports that additional transformers are required for the Beach pumping station. The cost is estimated at $20,000. The Board of Control has the matter under consideration.

Guelph, Ont.—The Water Commissioners have awarded the following contracts for annual supplies:—Cast iron pipe, National Iron Works, Toronto; valves, Kerr Engine Co., Walkerville; brass goods, Canada Brass Co., Galt.

St. Lambert, Que.—Tenders will be received up to May 28, for the supply and installation of a horizontal shaft centrifugal pump, electric motor and switchboard. Specifications may be obtained from H. A. Gibeau, town engineer.

Rosthern, Sask.—A by-law will be prepared to raise $25,000 for the purpose of purchasing an electric light plant. Underwood & Murphy, engineers, of Saskatoon, have advised that a 100 h.p. plant be installed but the council favors a 75 h.p. unit.

Alliston, Ont.—It is proposed to raise $32,000 to provide for the taking over of the Alliston electric light plant and repairing and improving same for the purpose of distributing electric power to be supplied by the Hydro-Electric Power Commission of Ontario.

St. John, N.B.—Tenders will be called shortly for the erection of a power house and laundry at the General Hospital. The estimated cost is $46,000. Full particulars may be obtained from F. Neil Brodie, architect, St. John, N.B.

I. J. Tait, formerly chief engineer at the Windsor station, Montreal, has recently become associated with J. T. Farmer, sales representative for the Green Fuel Economizer Co. and the Combustion Engineering Corporation of New York.

J. T. Farmer, 314 Coristine Bldg., Montreal, who for several years has handled the Canadian business of the Green Fuel Economizer Co. of New York, has in addition to this, the agency for Canada, for the Combustion Engineering Corporation also of New York; this firm manufactures a line of underfeed stokers.

Toronto, Ont.—Tenders will be received up to Tuesday, June 5th, 1917, for the sale and removal of four horizontal return tubular boilers from the west boiler room of the City Hall, Toronto. Copy of terms and conditions may be seen, and tender form obtained, together with all information relative thereto, at the offices of the Property Department, City Hall.

Aurora, Ont.—At a meeting of citizens held in the Town Hall here on May 2, E. C. James, civil engineer for the county, explained a suggested sewage system for the town, illustrating the plan with diagrams. The estimated cost of the improvement is $80,000, and it was the opinion of the meeting that the matter should not be considered until after the war.

Winnipeg, Man.—Tenders for the supply of valves for the Greater Winnipeg Water District were as follows:—Crane Co., Chicago, $15,038.70; Canadian Fairbanks-Morse Co., $12,749.92; Kennedy Valve Co., Elmira, $12,345.44; Rensselaer Valve Co., Troy, $12,196.54; General Supply Co., Winnipeg, $12.184; Drummond, McCall Co., Montreal, $11,138.25. No tender was accepted.

Brantford, Ont.—Tenders will be received by the secretary of the Board of Water Commissioners, until May 28, for two electrically-driven turbine pumps with capacity of 300 gallons per minute each, also electric motors and equipment. Specifications, etc., may be seen at the office of the secretary of the Board, Brantford, or at the engineer's office, Chipman & Power, Mail Building, Toronto.

Winnipeg, Man.—Tenders, addressed to the chairman, Board of Control, will be received up to May 18 for the supply and delivery, f.o.b. cars Winnipeg, freight and duty paid, to siding on Saskatchewan Avenue at the Decarie incinerator, of two horizontal water tube boilers. Plans, specifications and form of tender may be obtained at the office of the city engineer, 223 James Avenue.

Elmira, Ont.—The ratepayers will vote on two by-laws on May 28. The first calls for a loan of $15,000 to the Elmira Transmission and Machinery Co. The

AGENTS WANTED FOR CANADA

FOR

High Efficiency Centrifugal and Turbine Pumps

Design and Material of Highest Class

PRICES MODERATE

LARGE NUMBERS OF

Special Designs for Special Requirements

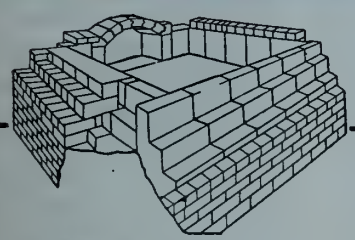
PULSOMETER ENGINEERING CO., LTD.

11 Tothill Street, LONDON and Nine Elms Iron Works, READING

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)



Gates Boiler Furnace
Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

—WRITE FOR PARTICULARS—

John W. Gates, 382 St. James St., Montreal, Que.

WALTER J. FRANCIS, C.E. M. Can. Soc. C.E. M. Am. Soc. C.E. M. Inst. C.E.
FREDERICK B. BROWN, M.Sc M. Can. Soc. C.E. Mem. Am. Soc. M.E. Mem. A.I.E.E.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS
Head Office, 232 St. James St., Montreal
Cable Address, "Walfran, Montreal"—W.U. Code.
Long Distance Telephone, Main 5643.

DON'T STOP ADVERTISING.

Keep your name to the front, so that you are in the market for the business that is going and for the new business that is coming. Do not let the world think that you have "gone under."

Structural Steel Work

Penstocks
Transmission Line Towers
Bridges
Steel for Dams
Oil Tanks
Air Receivers
Water Tanks

We carry a large stock of Steel Plates, Channels, Beams and Angles.

PROMPT DELIVERIES.

MacKinnon, Holmes & Co., Limited
Sherbrooke, Que., Canada

WATER SOFTENING OR FILTRATION
FOR BOILER FEED AND ALL INDUSTRIAL USES
WM B SCAIFE & SONS CO. PITTSBURGH PA

UNIFORM TEMPERATURES

Help produce better results at lower costs.

SARCO

TEMPERATURE REGULATOR

automatically maintains a uniform temperature at all times.

Watch It Work

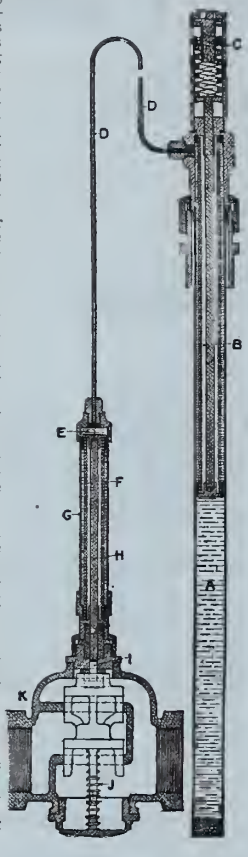
Thermostatic Tube A-B-C automatically operates the Controlling tube F-G-H.

In the Tube A-B-C, A is heavy hydro-carbon oil—which expands and contracts as the surrounding outside temperature varies. B is the spirally corrugated tube capable of expansion and contraction by the adjustment screw C, thus permitting a most minute and accurate adjustment for the maintenance of uniform temperature.

D is a small bore, heavy walled piece of tubing connecting both the sections, and making a closed system hermetically sealed.

In the controlling tube, F-G-H, is found the hydraulic principle so successfully employed in the Steam Trap Sarco. F is the corrugated expansion tube, G and E the sensitive heavy hydro-carbon oil, and H the piston plunger operating the balance valve K.

As the temperature increases at the location of thermostatic Tube A-B-C, the fluid A expands through the pipe D and develops hydraulic pressure against the head of tube F at the point E, thus depressing the piston H and closing the valve.



An operation entirely automatic and by hydraulic pressure. This operation is reversed as outside temperature decreases.

Sarco Temperature Regulator has many unique advantages. It is wholly self-contained and creates within itself sufficient hydraulic power to operate positively against any given pressure up to 200 pounds. It is small, compact, durable and 100% automatic.

Sarco Temperature Regulators are specially made and tested to meet the particular conditions for each installation, and they operate with equal efficiency for either gas, steam, water (hot or cold), or any liquid. They have a range for any given temperature from 60 to 250 degrees Fahr., and have an individual adjustment variation of 20 degrees. Regulators for higher or lower temperatures may be specially manufactured.

Sarco Temperature Regulators contain neither rubber, leather, nor metallic disc diaphragms. Low first cost, no maintenance, and require practically no space.

Write for Bulletin J—2.

SARCO COMPANY INC.

Woolworth Building New York,

Drexel Bldg., Philadelphia
New Telegraph Bldg., Detroit and Monadnock Block, Chicago
Canada: Peacock Brothers, Montreal

second provides for granting to the Phonola Co., of Canada, a free deed of $2,500 mortgage. The first company would increase its capacity by the addition of buildings 50 x 50 feet and 50 x 88 feet, and an extra dry kiln. The second company will begin operations at once.

Brockville, Ont.—The engineers are at work installing the cold storage apparatus in the new buildings of the Laing Produce and Storage Co., which was formerly occupied by the Bowie Brewing Co. The company expects to start work immediately on the installation of a milk condensing plant, which will have a capacity of 75 tons of milk daily. It is expected that this portion of the plant will be in operation by September 1st.

S. R. Sheldon, vice-president and chief engineer of Sheldon's Ltd., Galt, Ont., the well known manufacturers of heating and ventilating equipment, died suddenly after an operation for appendicitis aged forty. Mr. Sheldon was originally with the McEachren Ventilating Co. and about fifteen years ago took over the business with his brother W. O. Sheldon. The company was at a later date incorporated as Sheldons Ltd.

Regina, Sask.—Work on the construction of the new power house at Boggy Creek will be commenced shortly and the order for the new three million gallon electrical pumping unit will be placed before the end of this month. When the new unit is installed the capacity of the plant will be nearly doubled, and it would be possible to pump seven million gallons a day if that amount were required. The estimated cost of building and unit is in the neighborhood of $10,000. Two transformers will also be installed.

Mason Regulator & Engineering Co.—A new company has been organized in Montreal, under the name of Mason Regulator & Engineering Co., and has taken over the well known steam specialty business of H. L. Peiler & Co. there. The new company has also acquired the Canadian business of the Griscom-Russell Co. Eldon Macleod, treasurer of the Mason Regulator Co. of Boston, Mass., is president, while H. L. Peiler will act as treasurer and general manager. It is the intention of the new company to manufacture, in Canada, Mason reducing valves and other pressure regulating appliances, as well as "Bundy" steam traps and "Coppus" blowers besides the marine and steam specialties of the Griscom-Russell Co. These include the well known Reilly heaters, evaporators and distillers which enter so largely into marine equipment. All the other agencies controlled by H. L. Peiler & Co., will be retained, the business being carried along on the same lines as heretofore. The new company will have a greatly strengthened organization. Associated with Mr. Peiler will be E. J. Hatton, formerly of the Canadian Allis Chalmers Co., who will have charge of the manufacturing and erection work, while the sales end will be taken under Mr. Peiler's supervision, by E. T. Jeffrey, formerly of the John McDougall Caledonian Iron Works, and H. E. Kirkham. The Toronto office will be in charge of J. Collins, late manager of the Canadian Steam Boiler Equipment Co., who is well known to the engineering fraternity in Toronto. The offices of the old firm at 380 St. James St., Montreal, have been overhauled and additional space acquired for taking care of the increased business anticipated.

CATALOGUES

Niagara Motors.—Bulletin being distributed by the Niagara Motors Corporation, Buffalo, N.Y., dealing with an interesting line of gasoline motors for power boats. Specifications give the principal dimensions and weights, etc., of the various models, some of which are illustrated and their principal features described. A number of power boats are also illustrated featuring the suitability of "Niagara" motors for various kinds of service.

Searchlight Projectors.—An interesting catalogue has recently been issued by Crompton & Co., Chelmsford, England dealing with searchlight projectors for naval and military and general purposes. The catalogue contains a general description covering a wide range of sizes of standard searchlight projectors including particulars of the main features of their construction. The various types are illustrated and particulars given regarding current and range etc. of all sizes. The concluding pages contain information covering special attachments and applications.

Cameron Babbitt Retainer

(Patented in Canada and the U.S.A.)

Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box.

The only satisfactory compound for retaining molten metal and can be used over and over again for months—no deterioration.

For any metal.

For prices and samples apply to

A.S.K. Chemical Company, Elora, Ontario

Step up, boys, and meet Jeff Erson

Jeff is a sort of a specialist. He's made a thorough study of a subject in which every power plant engineer and naturally every superintendent is vitally interested—the elimination of leaks in power lines.

He has found that whether it be a high pressure steam line, an air line or a water line, its connections will give less trouble if they are made with

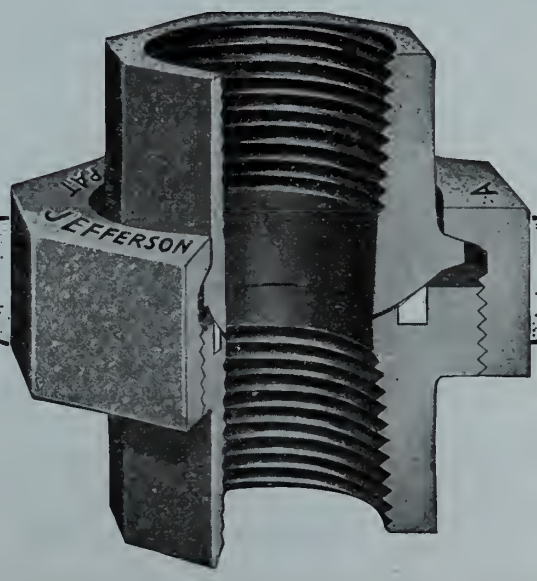
Jefferson Unions

He is going to be with you in Canadian Power House every month and he is going to show you just where it is to your advantage to hook up every line in your plant both on high and low pressures with Jefferson Unions.

So watch out for Jeff—we assure you his little monthly visit will be profitable to you. And, we almost forgot, Jeff has a well-worth-having book he wants to give you. Just drop a card to him at the address below.

Jefferson Union Company

Lexington, Mass.



If any advertisement interests you, tear it out now and place with letters to be answered.

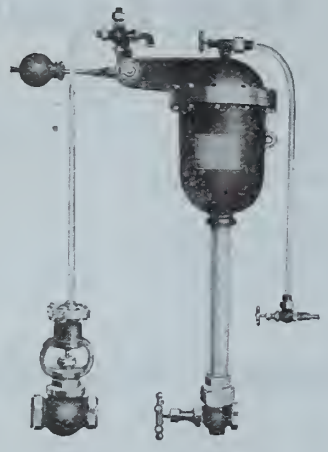
It may never happen to you—but are you SURE it WON'T?

Accidents due to high and low water are occurring continually. Your plant may never suffer, but have you assurance that it won't? Have you taken the necessary precautions against this danger?

The Vigilant Feed Water Regulator is guaranteed to keep water level within ¼" of middle gauge. It is a positive prevention of dangers arising from high or low water.

Investigate it to-day!

The Chaplin-Fulton Manufacturing Company
28 Penn Avenue - - Pittsburgh, Pa.



DIXON'S SOLID Belt Dressing

"Is The Perfect Belt Dressing"

Put up in handy sticks and applied while the belt is in motion.

By using Dixon's Belt Dressing every ounce of "pull" in a belt is quickly made available. Yet the composition of this dressing is such that it will not cause belts to crack or harden.

Better send for a free trial sample now.

Send for booklet 222-O.

Made in JERSEY CITY, N.J., by the
Joseph Dixon Crucible Company
Established 1827
Sole Canadian Agents
CANADIAN ASBESTOS CO., MONTREAL, QUE.

Wanted—

Engineers to contribute to the Power House

THIS is a practical paper for practical engineers. It is an educational medium and out to help its readers. It is a technical school and a social meeting place combined. It is first, last and all the time an engineer's paper.

If you should meet two or three or a dozen of your brother engineers you would swap ideas—you'd tell of some idea you had worked out in your plant. Others would describe some pet schemes they had devised. And so you would be mutually benefited.

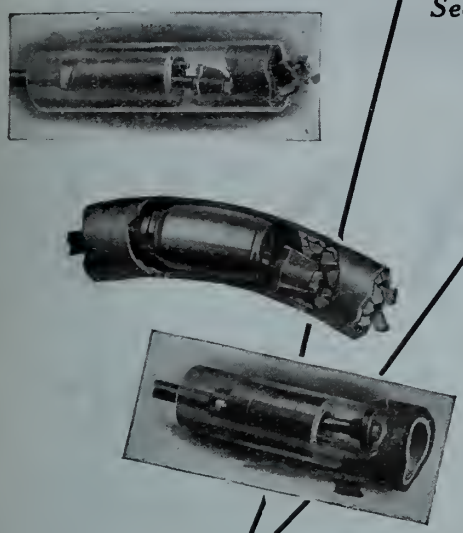
Why not make the Power House your monthly meeting place? Why not describe in this paper some kink or scheme you have worked out and found successful? We will pay you for it and you, in turn, will be multiplying the usefulness of your idea five thousand fold!

Never mind polishing up your letters—just give us the idea; that's the main thing. Never mind how crude your pencil sketch may be. We have draughtsmen who will finish up your drawings so they may be reproduced.

Try this idea a time or two and see how much satisfaction you'll get out of it. Start the ball a-rolling and thus help other engineers, yourself and your paper.

THE POWER HOUSE, 143-153 University Avenue, Toronto

A Louisiana Lumber Company Generated 33 1/3% More Steam Using This Tool



See Square below

The Pelican Cooperage & Lumber Co., Mound, La., required 33 1-3% more steam. At first, they thought about installing a new 150 H.P. boiler. Then they saw one of our advertisements, sent for a tool, cleaned up their boiler tubes and produced 33 1-3% more steam—with the

Dean Boiler Tube Cleaner

You may try this cleaner in one of your own boilers FREE. Simply write "Send me a Dean for free trial," giving type of your boilers and outside diameter of the tubes. There are no strings to this offer. You are the judge. If the tool is not satisfactory, you ship it back at our expense; if it is O.K. we issue with every Dean Cleaner sold a guarantee that it will pay for itself in six months' time, or your money back.

Write, anyway, for booklet 136, "The Logic of the Dean."

YOU TRY IT FREE

Dean

The William B. Pierce Co.

153 Ellicott St., Buffalo, N.Y.

201-2 Coristine Bldg., Montreal, Quebec

Winnipeg Representative; W. W. Hicks 567 Banning Street

Dean

TRADE MARK

TRADE MARK

BETTER THAN BRONZE

THE NATIONAL MANUFACTURING CO., LTD.

Brockville, Ont., Sept. 27, 1916.

Magnolia Metal Co.,
Montreal, Que.

Dear Sirs:

We have been using Magnolia Metal for some time with good results. We are making Shrapnel Shells and have been finishing the body on the Ford-Smith grinder. These grinders come equipped with bronze bearings which give us a lot of trouble. We looked about for a substitute and tried Magnolia with very satisfactory results.

Yours truly,

THE NATIONAL MANUFACTURING CO.

PRACTICAL ENGINEER POCKET BOOK:

Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.

Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

OFFICE AND FACTORY:

225 St. Ambroise St. MONTREAL

If any advertisement interests you, tear it out now and place with letters to be answered.

Oil in the Arctic

CANADA possesses enough petroleum to last the world for a thousand years. This oil is found on the Mackenzie River — in the Arctic region. The discovery was made two years ago by Dr. T. O. Bosworth, who reported the story of his "find" to the Dominion Government, but it is only now that the people of Canada have given them the story of a national asset of momentous importance. The tar sands north of Athabasca and Great Slave Lake become oil fields of incalculable value near the mouth of the Mackenzie. Read this story, told by Dr. Bosworth himself, of Canada's and the Empire's exhaustless oil fields in

MACLEAN'S MAGAZINE *for* June

THEN have regard for the following highly interesting special articles and features of the June MACLEAN'S, always keeping in mind that they are by Canadians for Canadians—and so belong by right to MACLEAN'S MAGAZINE, whose elect purpose is to advance the development of Canadian writers and Canadian literature, and to make the Canadian people —the best of them—better informed concerning their own land and their distinguished sons and daughters.

Balfour at Washington

and the war preparations of the United States, by Agnes C. Laut. An interpretation of Balfour's mission to America as it relates to the Allies' cause and to the unifying of the great Anglo-Saxon peoples into an organized power for the conservation and development of human liberty and the rights of the common people.

William T. Dewart

A Character Sketch

The romantic and inspiring story of a Canadian—a member of a well-known Ontario family—who is now general manager of the Munsey publications in New York. The story is exceedingly well told by a remarkable man—Erman J. Ridgeway, himself a publisher of brilliant record.

Putting Pep into Parliament

The idea is that the work and proceedings of Parliament should be simplified and speeded up. Parliament is becoming more and more of a business institution and less and less a place for oratory. The work of Canada is too important and too vast to permit of elocution and casuistry and wire-pulling. **H. F. Gadsby**, a writer with any amount of "pep" himself, is the man who pleads that Pep should be put into Parliament.

Sunshine in Mariposa

By Stephen Leacock

The second instalment of his play whose setting and incidents are found in Ontario, Leacock's birthplace. Rich humor, and revealing Canada's premier humorous writer in a new phase of his astounding versatility.

James B. Hendryx

continues "The Gun Brand." This is a romance of the Canadian Northland. An adventurous and ambitious girl teaches school in Athabasca, and in her journeyings thither and in her life and work later on, there are incidents and experiences and developments laden with thrills. A fine story which can be satisfactorily begun in the June MACLEAN'S.

Sir Gilbert Parker

contributes "At Lake O'Calling."
This is a Canadian story—about the building of a railroad for Empire business. A romantic tangle gives the story zest and shows Sir Gilbert's art finely. Probably his best story ever appearing in MACLEAN'S MAGAZINE

A. C. Allenson

contributes "June Comes Back."
A very beautiful June bride story—about June Summers, a charming young woman.

Arthur Beverly Baxter

contributes "The Man Who Scoffed." A war story—and good war stories at this time have great appeal. We all want to know more about the life our glorious Canadian boys are living in these epochal days. Romance mingles itself with death and tragedy.

Hopkins Moorhouse

contributes "The Herald Angel."
One of his fine Andy Doolin stories—a story of the days of the forty-niners with their lawlessness and enriching labors. A story of valor and primitive passions in freeset exercise.

Records of Success

This is a feature department of MACLEAN'S given over to sketches of interesting Canadian men and women who have accomplished things.

Review of Reviews

A department tremendously well liked by every MACLEAN'S MAGAZINE reader, for here are found condensations of many articles of surpassing interest appearing in other magazines. So do readers keep themselves informed concerning what is best and most vital in current thought and life.

SO you have evidence of just how much worth-while MACLEAN'S MAGAZINE is—how admirably it is doing its chosen work and realizing its own purposes; which are to give the Canadian people a magazine dominantly and usefully Canadian, and which will satisfy from beginning to end.

At all News-dealers, 15 cents

"I have about 25 Davis Traps of various sizes in service, the majority of them for 22 years. I will gladly recommend them at all times," wrote H. F. Hustedt, Chief Engineer, Tulane University, New Orleans, when ordering his first repairs.

Possibly all Davis Traps would not last that long without repairs. Much depends on the operating conditions. On some installations they last longer than on others. But all Davis Traps have Tobin Bronze seats and valves—a hard, tough metal from which long service may be expected.

And when these vital parts of the trap do wear out, they may be easily renewed at slight expense.

We make Pressure Regulators . Balanced Valve . Float Valve . Steam Trap . Back Pressure Valve . Exhaust Relief Valves . Stop and Check Valves . Pump Governors . Damper Regulators . Radiator Air Valves . Emergency Stop Valves.

G. M. Davis Regulator Co.

434 Milwaukee Avenue, Chicago., Ill.

New York, 123 Liberty—Boston, 70 High—Philadelphia, 260 N. 11th—The Renshaw Bldg., in Pittsburgh—Calvert in Baltimore, and Rialto in San Francisco.

Valve Specialty Manufacturers Since 1875

Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

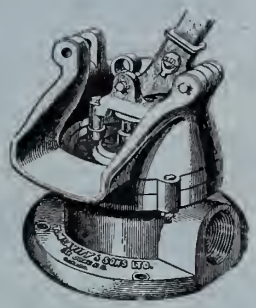
Regulating Valve Placed at Any Point, Any Position.

The "S-C" Regulator Company

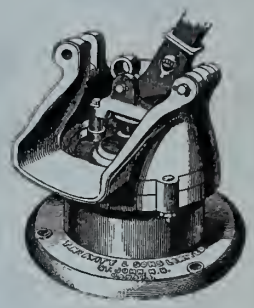
Feed Water Regulation Engineers

FOSTORIA, OHIO, U.S.A.

"WORLD" PUMPS



Side Inlet
For 3-in. Rubber Hose.



Bottom Inlet
For 3-in. Iron Pipe.

FOR

CONTRACTORS WATER WORKS MINES AND QUARRIES

These pumps will discharge water containing sand, gravel, coal dust, mud, drainage or any semi-liquid matter without choking or perceptibly wearing the pump.

These pumps have a hole in the lug in which to fasten a rope used in hoisting and lowering pumps into trenches, etc.

Write for copy Pump Catalog

T. McAVITY & SONS

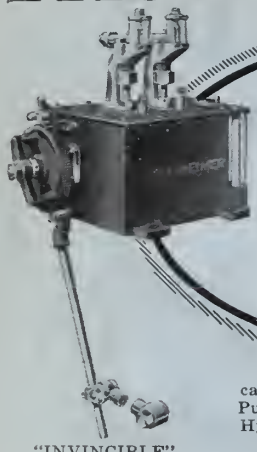
LIMITED

St. John, N.B., Canada

Montreal **Winnipeg**

If any advertisement interests you, tear it out now and place with letters to be answered.

"Friction losses minimized"—



"INVINCIBLE" Mechanical Oil Pump

spells efficiency in power production and increased life to the bearing of power units. Of equal importance to using the most suitable lubricant is the device for feeding it, and the type used should be governed by the service conditions to be met. The lubricator should utilize every drop of oil put into it, the feed should be easily regulated, positive and uniform. From the extensive line of

LUNKENHEIMER Cylinder Lubricators

"JUNIOR" Single Connection Hydrostatic Lubricator

can be found a type for every service condition, from the Multiple Feed "Invincible" Mechanical Oil Pump for High Pressure Steam and Diesel Oil Engine Cylinders to the small size single connection Hydrostatic Lubricator for Steam Pumps and Portables.

Every one a practical design—developed for a particular service; highly efficient in operation and very durable. Let us help you choose the type best suited to your individual case.

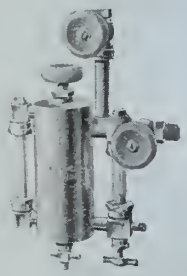
The Hand Oil Pumps are for use as auxiliaries to the cylinder lubricator, for forcing an additional quantity of oil to the cylinder when starting or for emergency.

The name "Lunkenheimer" on the lubricators of steam power units is a guarantee of service, satisfaction and economy.

Specify "Lunkenheimer" and insist on having the genuine.

Your local dealer can furnish them; if not, write us.

Write for Booklets 526—DC and 572—DC which illustrate the most complete line of high grade lubricators made.



"SENIOR" Double Connection Hydrostatic Lubricator

"ALPHA" Hand Oil Pump

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High-Grade Engineering Specialties in the World

Cincinnati, O., U.S.A.

New York Chicago Boston London

22-8 43

Representatives:

J. M. Allen, 65 Bloor St. W. Toronto, Ont.

Wm. Reid, 27 Celebration St. St. John N.B.

Plibrico—Endorsed by some of the leading Engineers as the GREATEST FURNACE LINING OF RECENT TIMES

Plibrico—makes a solid one-piece lining without joints. Absolutely gas and air-tight. Saves its cost in fuel in a month or two—you will have a steady fire with less effort and less coal by using it.

Plibrico—is mixed ready for use, requires only half the time to install and does not require skilled labor. Any laborer who is at all familiar with the building line can use it. DOES NOT BREAK, CRACK OR SHELL OFF LIKE ORDINARY BRICK.

Can be used for front door arches, side walls, brick walls, combustion chamber and rear arches. *Sets quickly*—after a few hours with a low fire to drain out the moisture, you may fire up as usual. No special forms required.

Ideal for temporary repairs. Better order a bærrel and have it ready for an emergency.

Plibrico Bond—A high temperature cement for repairs

"PLIBRICO BOND" is a product which gives a perfect bond between fire-brick, and does not allow the fire to burn out the joints, as is the case where fire-clay is used. Prevents furnace walls from cracking and crumbling.

It's the most practical and logical high temperature mortar you can use. It's the ever-ready repair cement that you should have in case of emergency.

Canadian Sales Agents

BEVERIDGE PAPER CO., Limited
Montreal, P.Q.

DART UNION

Couple up your pipe lines with Dart Unions

and be forever free from leaky connections

The permanent efficiency of Dart Union Pipe Couplings is due to the fact that *BOTH FACES ARE OF BRONZE,* which you know, will not rust or corrode and cause deterioration.

IRON PARTS ARE HEAVY—they will not stretch or pull apart.

Dart Unions are easily and quickly connected whether pipes are in or out of alignment.

A trial is well worth while. ORDER FROM YOUR JOBBER.

Made in Canada by
DART UNION COMPANY, LIMITED
TORONTO, CANADA

DART

GARLOCK

PUMP VALVES

The service of pump valves depends upon the compounds as well as the consistency and cure of the valves. The compounds used in Garlock pump valves have been established after years of trial in actual service and under the most severe conditions. Pump valves should always be used for the purposes for which they are intended. The following are a few of our leading styles and grades of valves:

Style No. 139—For medium pressure cold water
" " 175—For high pressure cold water
" " 182—For warm or greasy water
" " 108—For hot water
" " 105—For boiling water
" " 154—For air compressors and condensers

We guarantee our pump valves to give satisfactory service when used under conditions for which they are intended.

THE GARLOCK PACKING COMPANY

HAMILTON, ONTARIO

Branches:

Montreal, Quebec - - - 409 Shaughnessy Building
Toronto, Ontario - - 404 Continental Life Building
Winnipeg, Manitoba - - - - - Galt Building

Let Us Prove the 100% Efficiency of our Belting

It's the PROOF that gives the PUNCH that drives home the TRUTH of the McLAREN ARGUMENT.

Let us furnish you with PROOF of the 100% EFFICIENCY of this D. K. McLAREN'S BELTING.

Let us prove that this GENUINE - BRITISH - OAK - TANNED - BELTING will endure the severest strains and minimize slippage and stretching — and let us prove that it will last as long as it is possible for any belting to last.

No Slipping
No Breaking
No Stretching

McLaren's reduces the costs

It pays to use McLaren's

We can prove the claims for our belting by putting you in touch with reliable firms that have used McLAREN'S and other belting and know whereof they speak. If you want the proof, write to us.

Made with Enduring Qualities

Used in Largest Plants

Investigate this Quality Belting

D·K·McLAREN LIMITED

Head Office and Factory:
351 St. James Street, Montreal, P.Q., Canada
TORONTO, ONT.: 194 King St. West.
ST. JOHN, N.B.: 90 Germain St.
VANCOUVER, B.C.: 847 Beatty St.

Sliptivity
SteamCylinder

Sliptivity
Steam Engine

Automobile
Cylinder

OILS

These Lubricants give remarkable service. They will keep your machinery running smoothly, easily and with a minimum of wear and cost.

No better time than now to put them to the test. The prices are very reasonable.

Potato Scale Powder Boiler Cleanser

Will positively rid your boilers of old scale and will *keep* tubes clean if but a small amount is fed daily through the feed water.

Eliminates foaming, pitting or any other boiler troubles due to impurities in the water supply. *Makes big reduction in fuel bills.*

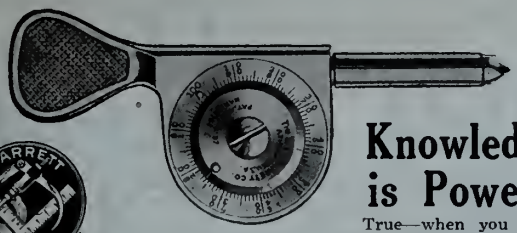
Sold UNDER A POSITIVE GUARANTEE. Try a Barrel.

C. C. SNOWDON

Oils Refiner, Manufacturer and Importer, Pennsylvania. Lubricating and Refined Oils, Gasoline, Potato Scale Powder, Liquid Soap, Disinfectants, Polish, Waste, Oil Tanks, etc.

Winnipeg—Cor. Notre Dame and Pine Sts., P.O. Box 1984.
Vancouver—822 Powell St.
Calgary—1S10-1840 Eleventh St. E., P.O. Box 1384; P.O. Drawer 166.
Edmonton—Cor. 13th Ave. and 83rd St., P.O. Box 877.

Good things for the POWER PLANT



STARRETT TOOLS
TRADE MARK REG. U.S. PAT. OFF.

Knowledge is Power

True—when you know how fast your engines are running, but how about the time when you don't know? That may be the very period when you are losing a large per cent. of power. Test your engines frequently with a

Starrett Speed Indicator

and the knowledge gained can be used in running your engines at just the right speed to give best results. This little indicator will test accurately auxiliary engines, motors, generators, turbines, line shafting, etc. It takes only a minute to test.

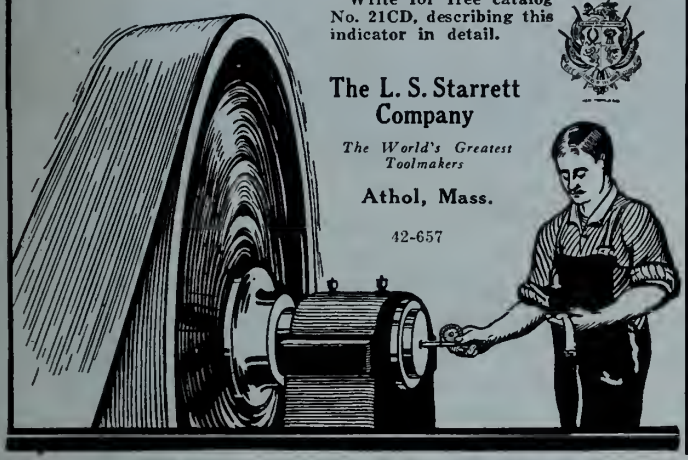
Write for free catalog No. 21CD, describing this indicator in detail.

The L. S. Starrett Company

The World's Greatest Toolmakers

Athol, Mass.

42-657



BOWSER

ESTABLISHED 1885

Lubricating Oil Filtering and Circulating System

5F TYPE

THE Bowser System of batch filtration of lubricating oil is recognized by all engineers as being the most efficient for turbine use. Systems such as the one illustrated are built for any capacity; the precipitation and filtering area are features that appeal to every engineer.

Filter sections are easily accessible and removable for cleaning, and can be cleaned after removal, with utmost ease.

Write us for detailed information to-day.

S. F. BOWSER CO., Inc.
Fort Wayne, Ind.

Sales Offices in all Centres *Representatives Everywhere*

WE watched them run the big truck out of the yard: smoothly, almost noiselessly, it glided away. And in our minds we contrasted this with the noisy vehicle of ten years ago.

But almost any product can show improvement. Our own particular line has seen this change. The workman who objects to CLING-SURFACE "because it is hard to use" reminds one of the old lady who doesn't like automobiles because "they make so much noise." For the new semi-liquid CLING-SURFACE is perhaps easier to use than any belt dressing you can buy.

* * *

Changing it from the heavy paste of twenty years ago to the semi-liquid of to-day was not a simple problem. Not until 1915 were we ready to place it on sale. The preservative nature of CLING-SURFACE would not permit the use of any solvent, such as gasoline or turpentine. Nothing evaporative could be employed, as CLING-SURFACE must not oxidize, turn rancid or form sediment, for what it does in the open it will do in the belt, and there it should preserve and lubricate the fibres.

So, while twenty years ago it was necessary to heat the CLING-SURFACE, to-day (in ordinary temperatures) it is used cold.

CLING-SURFACE is applied with a stick, say two feet long by one or two inches wide and half an inch thick, around one end of which is wound and wired a cloth bandage. At no time, therefore, is the operator in danger, for he is able to keep away from all moving parts.

* * *

CLING-SURFACE immediately stops the belt slip and removes any static electricity in the drives. Its continued use means mellow, pliable, waterproof and slip-proof belts, long-lasting and hard-working, saving you in power, oil, belting, coal, trouble, and men's and machines' time an amount annually which makes the price of CLING-SURFACE insignificant.

Ask us for the plan 10,000 firms have found successful. Our co-operation is free and our guarantee means something.

Remember, use CLING-SURFACE and you wont need belt dressings.

Cling-Surface
the life preserver for belts
TRADE MARK

Cling-Surface Co

1057 Niagara Street
Buffalo New York

If any advertisement interests you, tear it out now and place with letters to be answered.

The Publisher's Page

TORONTO May, 1917

What Gives Value to Trade Names

IN these days when a trade name may be made to be worth a million dollars or so a letter, the desire of manufacturers to find the proper trade name can well be understood.

To all manufacturers there is a valuable suggestion in what the American Ever Ready Works says about its new trade name, "Daylo," as reported in *Printers' Ink* last week. This name was selected on the basis of a referendum to the public. It was chosen by competent judges as the best of the thousands of names submitted, and yet the company confesses itself somewhat disappointed in the results.

"We had hoped," it said, "perhaps to obtain a word that would satisfactorily combine in a suggestive way both what Eveready is (powerful, portable electric light) and the variety of service it renders. We are now convinced that no usable protectable word could cover so broad a field."

But every manufacturer who has developed a successful trade name knows that if the company advertises persistently some day the word "Daylo" can be made to mean just what the company wishes it to mean. "Kodak" in the beginning had no meaning whatever. It was an arbitrary collection of five letters. But to-day consumers know what Kodak means because the company has given it a precise meaning through its years of intelligent advertising.

The American Ever Ready Works need not feel disappointed; but *its work is just begun. It must now give a meaning to "Daylo" which everybody will understand, and that means advertising. "Daylo" can be made to mean as much or as little as the company will. If the company depends upon the word alone to do the educational pioneering for the company's goods, it will mean little. If a strong volume of educational advertising is put behind the name, in time it can well prove its value to be worth a million or even two million dollars a letter.*

This is good philosophy, gentlemen, be it applied to flashlights or to files; to furnaces or forging presses or any other product.

Good advertising will give a name a value and a significance which it could not otherwise possess. Yes, advertising goes even further than that, because it creates in the buyer a sense of security and a feeling that there is something in the advertised product besides mere material, brains and skilled labor.

THE POWER HOUSE

143-153 University Avenue Toronto, Canada

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

STANDARD SUPER-HOT SPECIAL SOFT RED CONDENSER

Rub-Steel Valves

"THE VALVE WITH A BACKBONE"

WHAT IS IT? The Rub-Steel Valve is a valve made by a combination of rubber and steel.

THE CONSTRUCTION The construction consists of a plate of high grade steel placed in the center of the valve with a specially tough and lasting rubber composition on each side and edge, attached securely and lastingly to the metal by the Elchemco process, which chemically unites the rubber and steel.

THE PURPOSE The steel plate gives such strength to the valve that the highest pressure cannot warp, twist or in any way get it out of shape, while the rubber surfaces afford the proper seating qualities. **"Better than Metal Because of the Rubber—Better than Rubber Because of the Metal."**

WHAT IT ACCOMPLISHES It gives the valve a rigidity of form. It keeps the surface of the valve in its normal true position and insures a better seating quality. It prevents the high pressure from forcing the valve through the grating. It prevents the rubber from breaking up and the pieces causing trouble. It holds the surface of the valve in shape, so that when one side becomes worn the valve can be reversed without dressing. It is thinner and therefore gives greater efficiency to the pump. It permits the use of a softer valve for hot water, thus securing a better seat on worn or uneven "grids." It ensures an even distribution of the pressure, preventing "dishing" and the consequent cutting of the valve.

WHY YOU WANT IT **Because** its ultimate cost is less than that of ordinary type valves. **Because** it will last longer than other valves. **Because** it saves time and annoyance of replacement. **Because** its construction at once appeals to you as practical and sensible.

SOLE CANADIAN AGENTS

The Canadian Fairbanks-Morse Co., Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

SPECIFY DURABLA PACKING

DURABLA
TRADE MARK

DURABLA
TRADE MARK

Note the Durabla Trade-Mark all over the sheet. A Guarantee of Quality.

Durabla is a Long Fibred Asbestos Sheet sold on Service Basis and guaranteed to make a Tight Joint.

It is the Bond that is the most important part of an Asbestos Sheet.

Only when you combine the right Binding materials with High Grade Long Fibred Asbestos do you secure a perfect Asbestos Sheet Packing.

Therein lies the Secret of the wearing Quality of Durabla, the Packing that will keep any joint tight, and stand everything that the Flanges will stand.

Durabla does not crack or dry out. It can be rolled and unrolled and will not deteriorate in stock.

On saturated and superheated steam, High and Low Pressures, Air, Gas, Oil and Ammonia, Durabla will keep your Flanges tight and give you Lasting Service.

DURABLA MANUFACTURING COMPANY

New York

Canadian Distributors:
THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

Toronto Montreal Winnipeg Calgary Vancouver Windsor St. John Victoria Ottawa

Every Engine-Room Needs an
AMERICAN-THOMPSON IMPROVED INDICATOR

The Savings to be made by its use will be felt in every factory department. Why not take advantage of it now?
(Installment plan of payment for Engineers, if preferred).

Catalog on request.

Sole agents for Canada: CANADIAN FAIRBANKS-MORSE CO., Limited, Montreal, Toronto, Quebec.

American Steam Gage & Valve Manufacturing Co.
New York Chicago BOSTON Atlanta Pittsburgh

MARTELL
PACKINGS
MEAN
MORE
POWER

Ask "the man who knows" in any power plant what he thinks of the Martell Packings. We will leave it to his verdict. Power House experts know the worth of these packings by their good name or by actual experience with them.

Failure is out of the question with these packings.

Cut at a tangent to piston rod, and joints on diametrically opposite sides of piston are parallel. This arrangement of the joints of the ring allows the parts to adjust themselves to slight inequality of wear in the diameter of the rod, as they float freely. Therein lies superiority of Martell packings. WHY NOT GIVE THEM A TRIAL?

The Martell Packings Company, Inc., Elyria, Ohio

Canadian Agents: THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

Escaping Steam Means Power Loss and Money Wasted

which can be prevented by using THE packing that gives long service even under hard conditions.

You can depend upon the lasting qualities of

TRADE MARK

"PALMETTO" PACKING

because it is uniform, both as to materials and methods of manufacture.

"Palmetto" Means Economy

Braided for rods. Twist for valves.

Let us send you working samples to prove quality—no charge.

GREENE, TWEED & CO.

Sole Manufacturers

109 Duane Street **New York**

Representatives in Canada;

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

St. John, Montreal, Quebec, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Edmonton, Vancouver, Victoria.

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

ALBERGER
MULTI-HEAD
WATER HEATERS

Vertical Type

Horizontal and Vertical

Various Types:

Feed Water Heaters, Domestic Service Heaters, Forced Circulation Hot Water Heaters, Heat Interchangers, Oil Heaters, Condensers, Air Coolers, Oil Coolers, Laundry Heaters, Wort Coolers.

MULTI-HEAD. Eliminates dangers of expansion strains common with other heaters.

THE ALBERGER PAVES THE WAY TO LOW COSTS—Gives maximum heat at minimum expense. ELIMINATES ALL TUBE TROUBLES and heats instantly.

The Spiral Corrugation of the ALBERGER keeps tubes clean and increases heat units by 50 per cent. over straight tubes. *Write for full data about this economic worker.*

Alberger Heater Co.

BUFFALO, N.Y.

GENERAL SALES AGENTS:

CANADIAN FAIRBANKS-MORSE CO., Limited

St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Winnipeg, Calgary, Edmonton, Vancouver, Victoria

Disc Economy

The Disc which has proved its lasting quality by over 25,000 openings under most severe conditions without injury, is the

BAKELITE DISC

Made in both Fairbanks and Jenkins type.

A full range of sizes for immediate delivery.

Specify "Bakelite" Discs on your order.

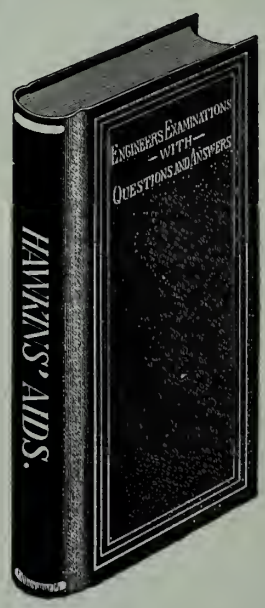
PLASTICS LIMITED TORONTO

Sole Sales Agents:

THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John, Montreal, Quebec, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Edmonton, Vancouver, Victoria.

Hawkins' Aids
Free to Engineers



This work is an important aid to engineers of all grades, and is undoubtedly the most helpful ever issued relating to a safe and sure preparation for examination. It presents in a condensed form the most approved practice in the care and management of Steam Boilers, Engines, Pumps, Electrical and Refrigerating Machines, also a few plain rules of arithmetic with examples of how to work the problems relating to the safety valve, strength of boilers and horse power of the Steam Engine and Steam Boiler.

It contains various rules, regulations and laws of large cities for the examination of boilers and the licensing of engineers.

The book gives the underlying principles of steam engineering in plain language, with very many sample questions and answers likely to be asked by the examiner.

It also gives a short chapter on the "Key to Success" in obtaining knowledge necessary for advancement in engineering.

This helpful volume contains 200 pages of valuable information not elsewhere obtainable; it is bound in rich red leather with full gold edges and titles; it measures 5x7½ inches, and weighs twenty-two ounces.

Price, $2. Free for 3 NEW prepaid subscriptions to The Power House.

THE POWER HOUSE

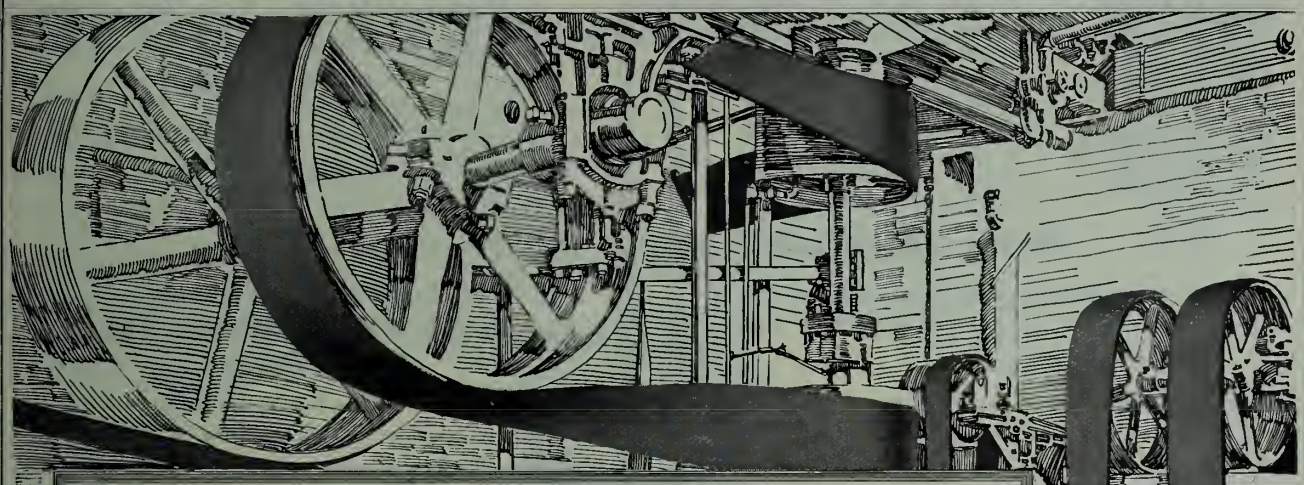
143-153 University Avenue, TORONTO

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

GRATON & KNIGHT
Standardized Series
LEATHER BELTING

Tanned by us for belting use



"Let's scrap our belting specification," said the Master Mechanic

The Purchasing Agent was startled. "Why?" he asked.

"It doesn't protect us," replied the M.M. "We buy lots of belting for First Quality that proves to be mixed with seconds and shoulder. We can't test every roll—and you know mighty well there's nobody in this shop wise enough to detect skillfully mixed belting."

"What'll we do?" inquired the P. A.

"I'd advise that we adopt the Graton & Knight Standardized Series as our own belting standards. They're the largest belt makers in the world—been 66 years developing and classifying their Series of Brands, until it covers every possible belt need. And the individual Brands run absolutely uniform—I've used enough to know that."

"How does it work?"—the Purchasing Agent was interested.

"You simply get a set of the Graton & Knight Standardized Belts as recommended for our needs, with the official description of each. Then when you need a belt, you select the brand that's right for the job—get bids on that or equal. Thus you make *actual service* the basis for comparison—not just a written specification."

"I'll go you, Joe," cried the P. A. "If there's one thing I've always wanted to standardize, it is our belting—but I haven't known how to go about it. I'll have the Graton & Knight salesman come and tell us how to do it. Be sure you're there, Joe."

* * *

Are YOU buying belts on discount—or on performance?

Do you KNOW when your specification is met—or do you take a chance?

The only way to be sure of belting is to have a simple, safe and trustworthy set of real belting standards to go by. Graton & Knight Standardized Series furnishes this.

Write to-day for the Graton & Knight Belting Book—or have the nearest Graton & Knight representative call on you.

The Graton & Knight Mfg. Company

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packing and Leather Sundries

Worcester, Massachusetts, U. S. A.

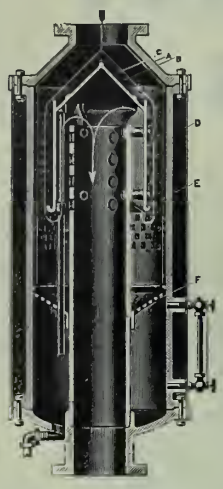
Canadian Representatives: **The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Edmonton, Vancouver, Winnipeg, Victoria**

GRATON & KNIGHT

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
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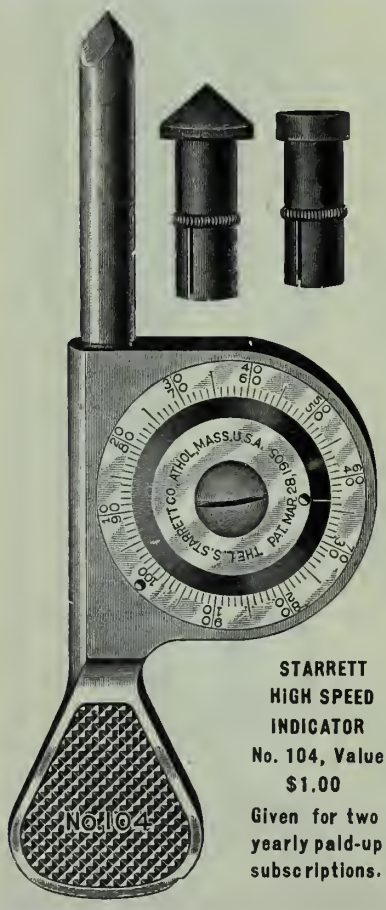

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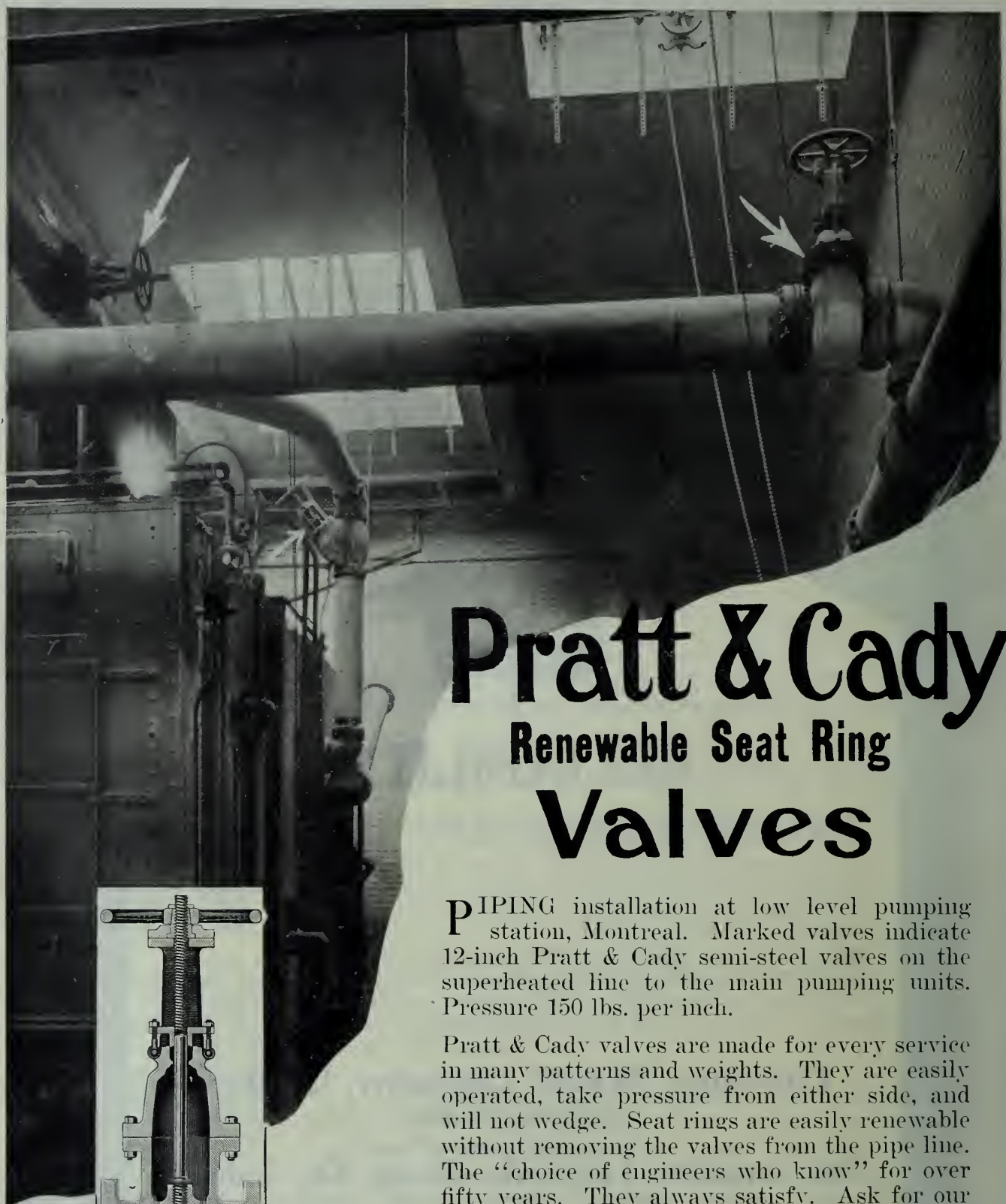

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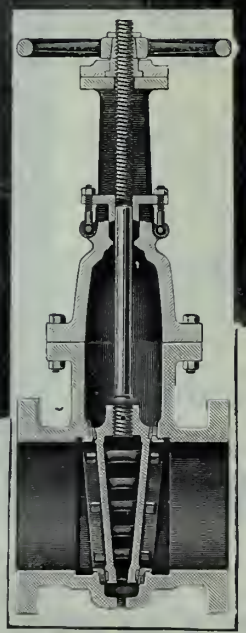
Renewable Seat Ring
Valves



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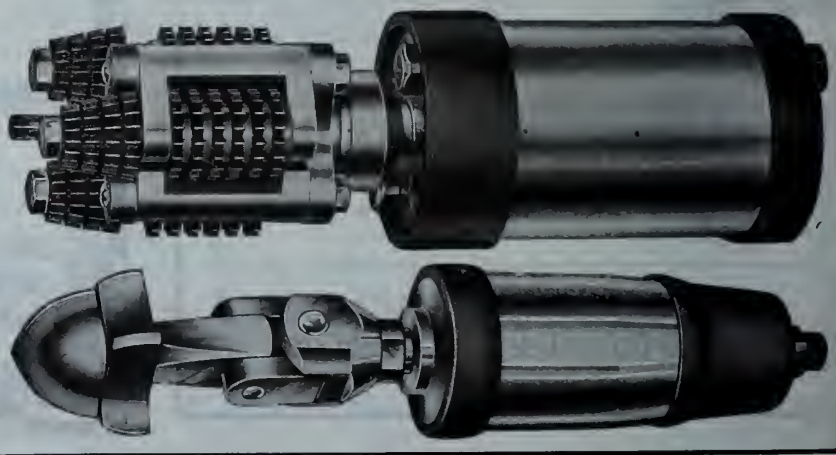

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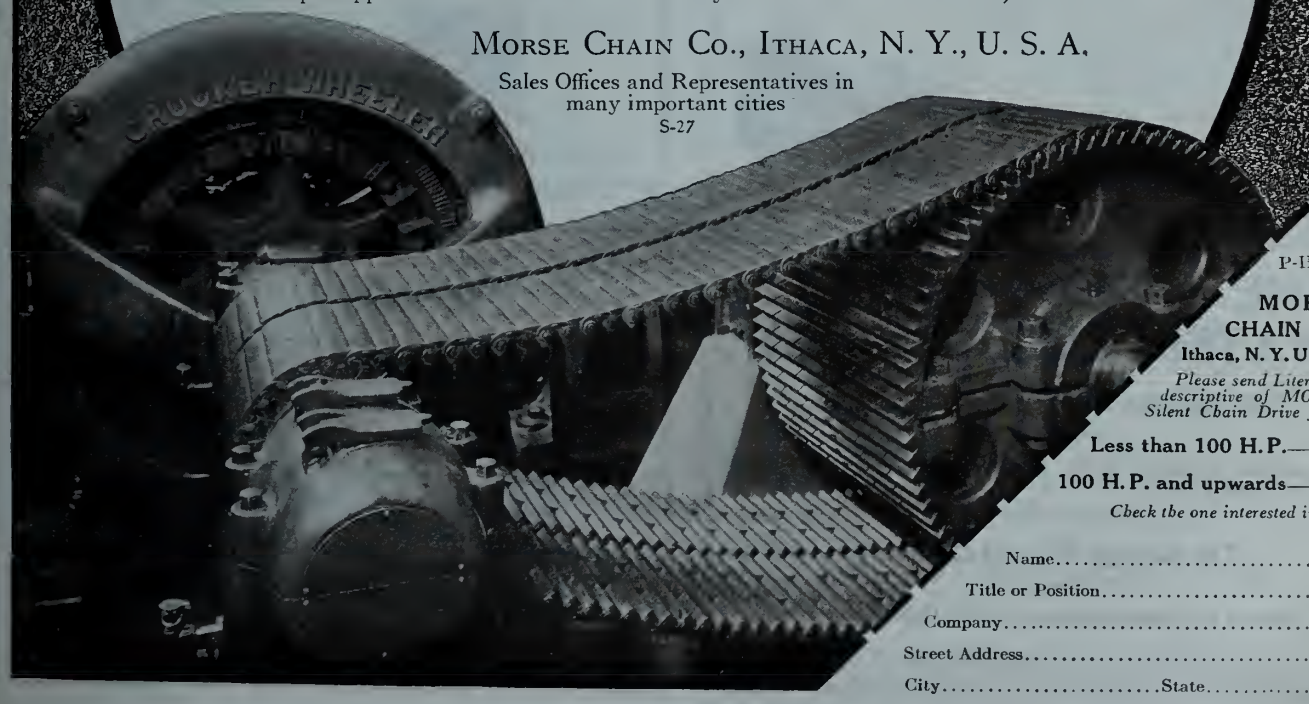

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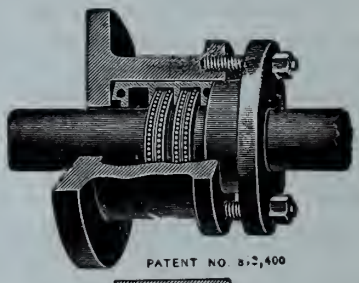

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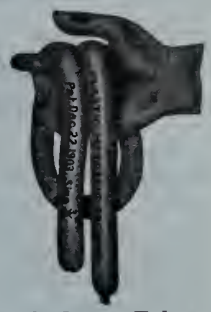

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In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

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Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways.

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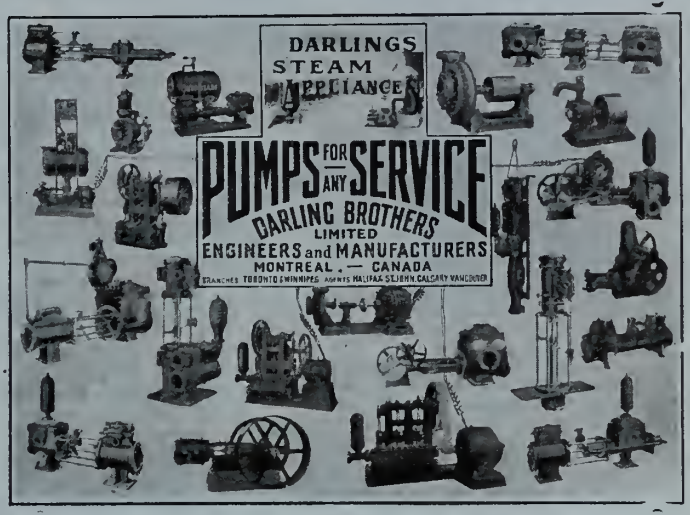

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Goldie & McCulloch Co., Galt.
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Garlock Packing Co., Hamilton, Canada.
Laurie & Lamb, Montreal.
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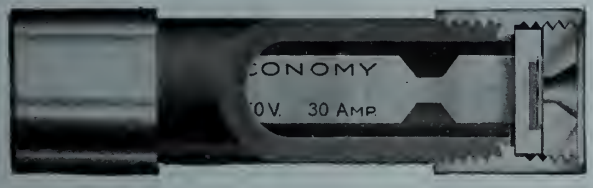

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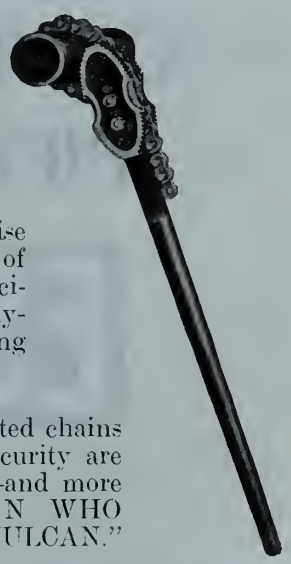

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Morrison, Jas., Brass Mfg. Co., Toronto, Ont.
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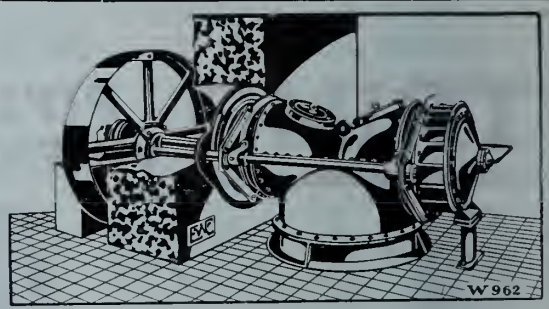
GOVERNORS
PIPELINES



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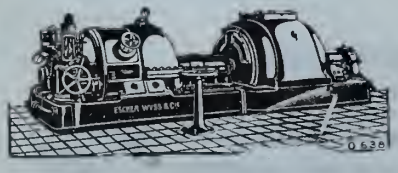
Zurich
Switzerland

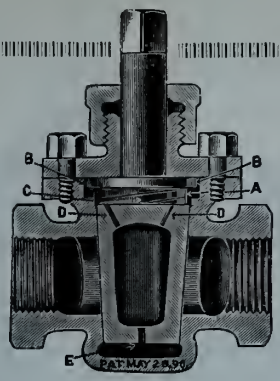
Zoelly Steam Turbines
Turbo-Pumps



MONTREAL OFFICE : 211 Coristine Building

62-17

Ideal for Frequent Opening and Closing



Built to Withstand Extra Severe Service

HOMESTEAD
QUARTER-TURN VALVE

Simple to operate. Stands the strain of severest service. Tightness made certain by patented wedging cam that automatically forces plug downward in closing and instantly releases it again when handle is turned to open valve. The Plug is always held in perfect balance by means of special ports. Quick opening to full area is obtained by quarter-turn of handle.

MADE IN STRAIGHT-WAY, THREE-WAY and FOUR-WAY PATTERNS. SPECIAL VALVES FOR SPECIAL PURPOSES.

Drop a card for full details.

Homestead Valve Mfg. Co.

Works: Homestead, Pa. Pittsburgh, Pa.

CURTIS
Engineering Specialties

CURTIS Water Pressure Regulator

The Economy of this Curtis Water Pressure Regulator (See Illustration) lies in the fact that it greatly reduces the cost of keeping plumbing in order—This by obviating the wear and tear of water hammer or concussion in pipes.

This regulator is warranted to maintain the pressure desired, **with perfect uniformity, regardless of any fluctuations of outside pressure.** The workmanship and material of the Regulator **cannot be excelled.** Trouble from rust or clogging is **entirely avoided.** Delivery of water into service pipes at any desired pressure **is guaranteed.**

Send for special leaflet and price list to the manufacturers.

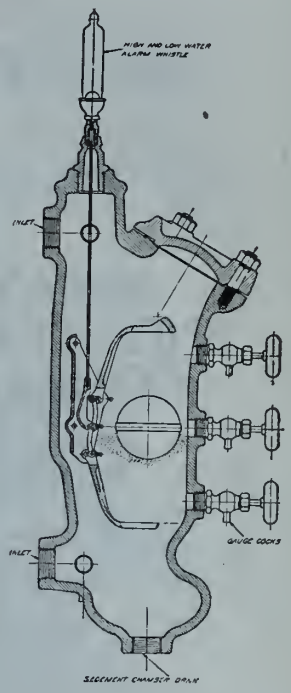
JULIAN D'ESTE COMPANY

26 Canal Street, BOSTON, MASS.

SAFETY CERTAIN

With High and Low Water Alarm

Exterior



Cross Section

The "Anderson" Safety Water Column

Safety first, safety last, safety certain all the time—that's the assurance that you get from the "ANDERSON."

Water in your boiler cannot rise above or fall below the danger mark without the WARNING WHISTLE OF THE "ANDERSON" giving the alarm.

POSITIVELY RELIABLE —Working parts cannot rust or stick.

Write for full details.

The V. D. Anderson Co.

1935 West 96th St., Cleveland, Ohio

If any advertisement interests you, tear it out now and place with letters to be answered.

SPRACO

COOLING SYSTEM

50% of the cost of installation is being saved yearly by plants which have dispensed with other cooling systems and adopted the "SPRACO." This should decide you in favor of the SPRACO SYSTEM, but that is not all; it's easier to operate and gives better satisfaction, besides making a big saving in power.

We guarantee that the Spraco System will be a success. We design the pond as well as furnish the nozzles. Ground and roof installations. Write for full data.

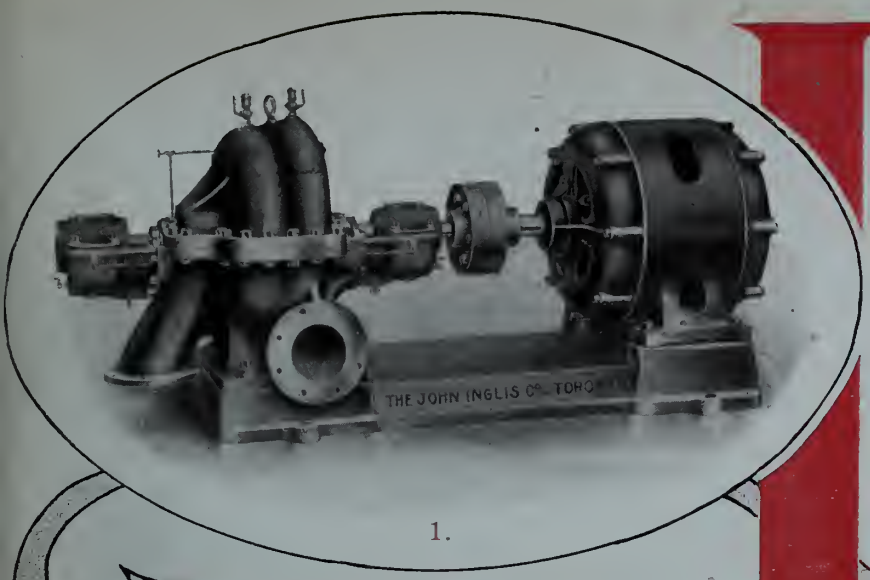
SPRAY ENGINEERING COMPANY

Engineers and Manufacturers
93 Federal Street,
BOSTON, MASS.
CABLE
"Spraco" Boston
Code: Western Union

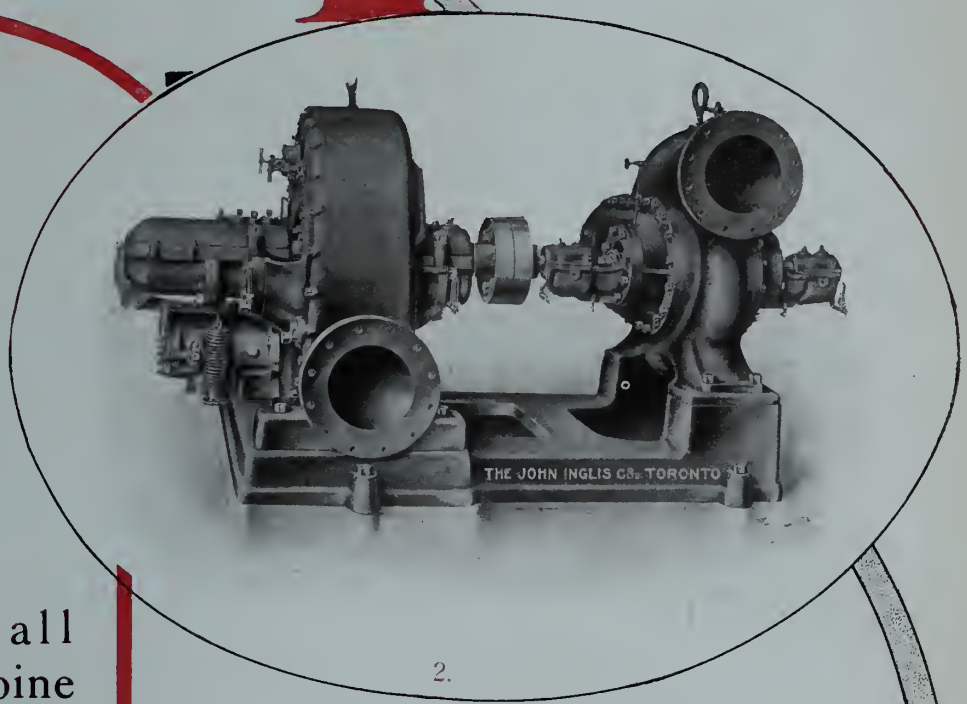
INDEX TO ADVERTISERS

	PAGE
A	
Albany Lubricating Co.	73
Alberger Heater Co.	68
American Steam Gauge & Valve Mfg. Co.	66
American Steam Pump Co.	15
Anderson Co., V. D.	87
Armstrong Cork Insulation Co.	11
A.S.K. Chemical Co.	52
B	
Babbitt Steam Specialty Co.	74
Babcock & Wilcox	78
Bawden Machine Co., Ltd.	7
Beveridge Paper Co.	58
Boiler Inspection Dept.	77
Boving Hydraulic & Eng. Co.	76
Bowser, S. F., & Co., Inc.	63
C	
Can. B. K. Morton Co.	14
Can. Detroit Lub. Co.	73
Can. Fairbanks-Morse Co.	65
Can. H. W. Jones-Manville Co. Ltd.	9
Can. Morehead Mfg. Co.	83
Can. Sirocco Co.	8
Can. SKF Co.	71
Chaplin-Fulton Co.	54
Cling-Surface Co.	63
Coe Co., C. T.	8
Coppus Eng. & Equip. Co.	7
D	
Darling Bros.	81
Dart Union Co.	59
Davis Regulator Co.	57
Dearborn Chemical Co.	17
D'Este Co., Julian	87
Direct Separator Co.	70
Dixon Crucible Co., Jos.	54
Dominion Belting Co.	74
Dominion Coal Co.	76
Durabla Mfg. Co.	66
E	
Economy Fuse & Mfg. Co. of Canada	83
Elliott Co.	47
Escher Wyss & Co.	86
F	
Foxboro Co.	78
Francis, Walter J., & Co.	51
Frick Co.	11
G	
Galt Foundry Co.	5
Garlock Packing Co.	60
Garth Co.	76
Gates, John W.	51
Goldie & McCulloch Co.	18
Graton & Knight Mfg. Co.	69
Greene, Tweed & Co.	67
H	
Holmes Metallic Packing Co.	76
Homestead Valve Mfg. Co.	87
Hoyt Metal Co.	2
I	
Inglis Co., John — Inside back cover	
J	
Jamison Cold Storage Door Co.	12
Jefferson Union Co.	53
Jeffrey Mfg. Co.	49
Jenckes Machine Co.	2
Jenkins Bros.	3
Jones Underfeed Stoker Co., Ltd.	8
Jordan Bros., Inc.	15
K	
Kerr Engine Co.	4
L	
Ladd, The Geo., Co.	76
Laurie & Lamb	13
Leitch Co., The Arthur S.	83
Linde Canadian Refrigeration Works Co.	10
Lunkenheimer	58
M	
MacGovern & Co.	85
MacKinnon, Holmes & Co.	51
Magnolia Metal Co.	55
Martel Packings Co.	66
Mason Regulator Co.	6
McAvity & Sons, T.	57
McDougall Caledonian Iron Works Co.	16
McGhie, W. C.	76
McLaren, D. K., Ltd.	
Morris Machine Works	15
Morrison Brass Mfg. Co., Jas. — Outside back cover	
Murphy Iron Works	1
Morse Chain Co.	75
N	
Nashua Mach. Works	6
P	
Peerless Rubber Co. — Inside front cover	
Peiler & Co., H. L.	6
Penberthy Injector Co., Ltd. — Outside front cover	
Pennsylvania Flexible Metallic Tubing Co.	70
Pierce Co., Wm. B.	55
Plastics, Ltd.	68
Pratt & Cady Co.	72
Precision Instrument Co.	81
Pulsometer Engineering Co.	51
R	
Roto Company, The	74
S	
Sarco Co., Inc.	52
"S-C" Regulator Co., The	57
Scaife, Wm. B., & Sons Co.	51
Schaeffer & Budenberg Mfg. Co.	7
Snowdon, C. C.	62
Spray Engineering Co.	88
Starrett, L. S., Co.	63
Steel Mill Packing Co.	77
Storey Pump & Equipment Co.	15
Sturtevant, B. F., Co., of Canada	49
T	
Taylor Instrument Co.	78
Thomas Grate Bar Co.	5
Trimont Manufacturing Co.	85
Toch Bros.	73
U	
Uehling Instrument Co.	81
V	
Vilter Mfg. Co.	10
W	
Wall, W. J.	51
Waterous Engine Works Co.	1
Watson & McDaniel Co.	76
Williams & Co., J. H.	85
Y	
York Mfg. Co.	12

Inglis Turbine PUMPS



1.



2.

Oil ring bearings, hydraulic balance and water-cooled thrust bearings are standard for all "Inglis" Turbine Pumps.

Impellers and passages are highly finished, all working elements being carefully balanced against vibration.

Send us your inquiries.

Illustration No. 1 shows our Multi-Stage Split Case Turbine Pump for medium and high pressures. Direct connected to electric motor.

Illustration No. 2 shows our Double Suction Pump for Circulating low or medium heads. Direct connected to steam turbine.

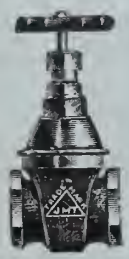
The John Inglis Company, Ltd.

Engineers and Boilermakers

14 Strachan Avenue, Toronto, Canada

Ottawa Representative: J. W. ANDERSON, 7 Bank Street Chambers

J. M. T. Steam Goods and Specialties


J. M. T. Gate Valve

Model C Safety Valve

Recording Gauge

Oil Cup

J. M. T. Reducing Valve

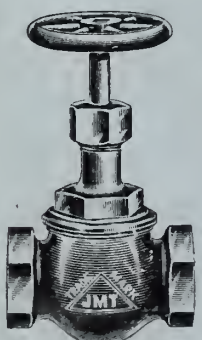
Gauge Cock

Beaver Valve

J. M. T. Injector

Gem Ejector

J. M. T. Check Valve


J. M. T. Valve

Big Quality

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

Big Value

An unconditional guarantee, plus 50 years' manufacturing experience, stand behind each and every line that we produce.

Morrison's steam goods are approved by Provincial and Marine Inspection Departments. Every article is tested before leaving factory.

We have a complete line of Power Plant Accessories and Fittings for every purpose.

Ask us for a catalog covering the line in which you are interested.

The James Morrison Brass
Manufacturing Co., Limited

89-97 West Adelaide Street
TORONTO ONTARIO

Morrison Cellar Drainer, the most efficient machine on the market. All working parts above water.

THE POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

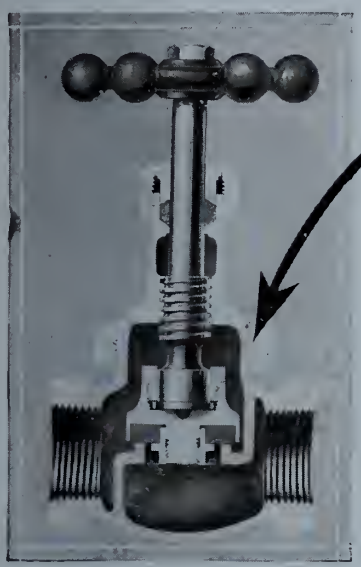
Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

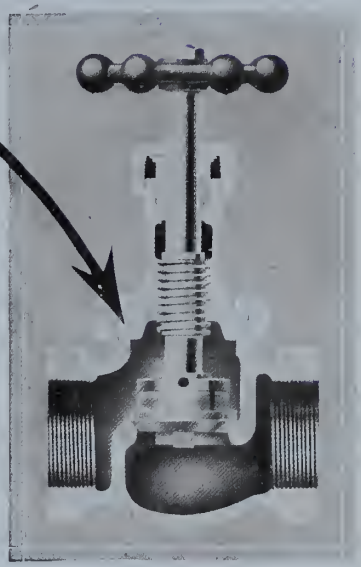
MONTREAL: Eastern Townships Bank Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 22 Royal Bank Bldg.

Vol X Publication Office, Toronto—June, 1917 No. 6

FILE COPY

ALL PENBERTHY VALVES HAVE THE EXTERNAL THREAD CONSTRUCTION





COMPODISK

FOR

175 lbs. Steam Pressure

The Discs used in these valves will not crack or flake under high steam pressures or severe conditions.

Thousands in use giving the best of satisfaction.

MADE IN CANADA

The Arrows Show You
DO YOU REALIZE
What this Modern Improvement Means to Every Engineer?

SAFETY FIRST

When you tighten down the bonnet of a Penberthy Valve there is **no danger** of spreading or enlarging the bonnet end of valve body which causes a loose fitting and unsafe bonnet **because** the Penberthy bonnet fastens to the body by outside threads. It's a union connection so to speak. These threads being **away** from corrosive action of steam and water are always clean, and the body and bonnet do not "freeze" together. A Penberthy Valve is therefore easy to take apart without strain or injury.

You will never know all the valve comforts until you have installed "the Penberthy."

REGRINDING

FOR

200 lbs. Steam Pressure

Some of the largest plants in Canada where this type of valve is preferred use Penberthy Regrinding Valves exclusively.

They are made in Globe Angle, Cross and Horizontal Angle, Vertical and Swing Checks.

MADE IN CANADA

Manufactured by

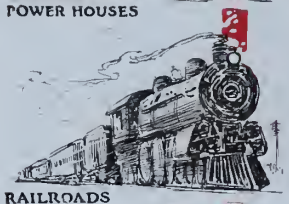
PENBERTHY INJECTOR CO., Limited, Windsor, Ontario

MAKERS OF THE "ALL QUALITY" LINE OF BRASS VALVES

FILE COPY

Where Ever Steam is Generated RAINBOW Finds a Use!

POWER HOUSES


RAILROADS

OFFICE BUILDINGS

STEAMSHIPS

HOTELS

THEATRES

MILLS

FACTORIES

RAINBOW

Over 50,000 engineers regularly specify RAINBOW, because it will make a tight joint that lasts for years.

RAINBOW has been used on every conceivable service in every industry. It's been tested so thoroughly that it is recognized as the standard sheet packing.

RAINBOW fits between the flanges like a mould. It is made of a compound that can't "burn" or "blow-out."

Start to use it to-day—you'll be more than satisfied.

"IT HAS NEVER FAILED ME IN OVER TWENTY-FIVE YEARS"

Peerless Rubber Mfg. Co.

31 Warren Street - New York

Canadian Asbestos Co.

Toronto and Montreal

SOLE CANADIAN DISTRIBUTORS

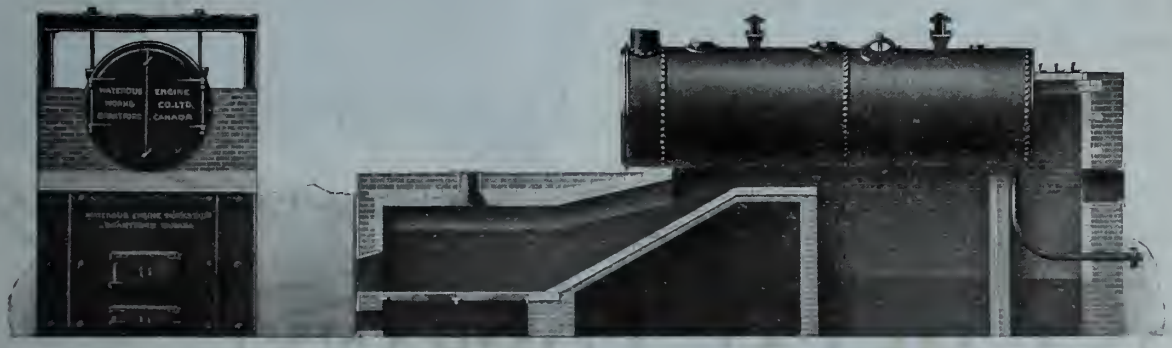
Waterous

Return Tubular Boilers

Combined with the advantages possessed in general by this type of boiler—economy in fuel consumption, large steaming capacity, ability to use hard and dirty water, and comparatively low cost — we can furnish you with a boiler setting that is designed and dimensioned to best handle the fuel you use.

We build Return Tubular Boilers up to 72″ x 18″. Most of these sizes carried in stock. If we cannot supply you from our yards we can turn out your order in quick time.

Let your next boiler be a "Waterous."



The Waterous Engine Works Co., Ltd., Brantford, Canada

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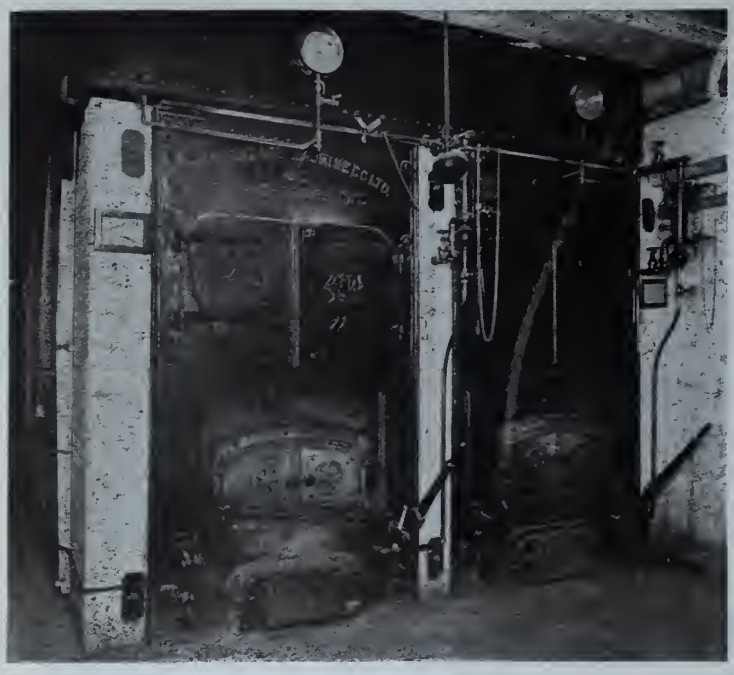


An Installation of JENCKES Boilers at the C.P.R. Station, North Toronto

A Jenckes Installation

An evidence of the quality of our boilers is in the illustration shown here. A request for information will command our immediate co-operation and help. We will solve your difficulty to your best advantage. Let us get together.
Our line is very complete. Write for information.

The Jenckes Machine Company, Limited

Sherbrooke Montreal St. Catharines Cobalt South Porcupine Nelson Vancouver

Works: **Sherbrooke, Que. St. Catharines**

"THE OLD RELIABLE"

Power houses in every quarter of the globe are users of

"Frost King"

BABBITT METAL

It must necessarily embody superior qualities, else it would not enjoy such widespread favor.
For Engines, Pumps, Rolling Mills, Pulp Machinery, Planing Mills, etc., it has no equal.
Order from your dealer—if he can't supply, have us ship you a 25-pound trial box direct.

"Nickel Genuine"—A Dynamo and Motor Babbitting Metal bearing every mark of Hoyt excellence in its composition. **Try it. You take no chances in Hoyt Metals.**

Babbitt Metal

40 Years Of Success

HOYT METAL COMPANY

Factory and Offices Eastern Ave. and Lewis St., Toronto, Canada; New York, N.Y.; London, Eng.; St. Louis, Mo.

TRADE JENKINS MARK
Jenkins Bros.

JENKINS BROS.'

TYPE "K"

BRASS GATE VALVES

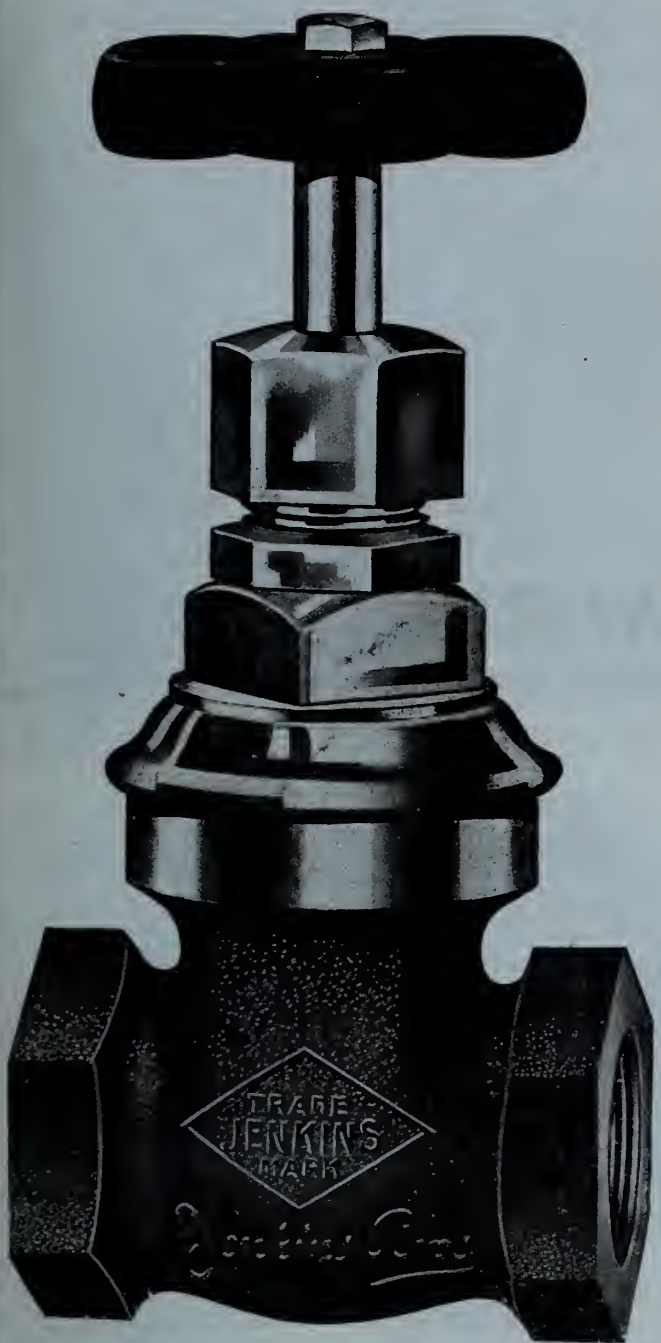


Fig. 300
TYPE "K" BRASS GATE VALVE SCREWED

Type "K" Brass Gate Valves

are different from ordinary Gate Valves because they are made from the best grade of metals in a modern factory under expert supervision.

Particular attention is paid to every detail in their manufacture, and before they are delivered for shipment every valve is carefully inspected and thoroughly tested under working conditions by both steam and hydraulic pressure.

Type "K" Brass Gate Valves carry the usual JENKINS BROS.' guarantee of Service and Satisfaction.

Your dealer will supply you.

Catalogue No.8 sent free on request.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

103 ST. REMI ST. MONTREAL

If any advertisement interests you, tear it out now and place with letters to be answered.

Murphy AUTOMATIC Furnace

AT A PRICE — if low enough and with probable or impossible guarantees —**anybody can get a first contract**

REPEAT ORDERS is the best evidence of merit in any device!

For the year 1916 we received REPEAT ORDERS from 63 leading industrial firms and corporations in the United States and Canada for **154 Murphy Stokers**—46,623 nominal H.P.; the 63 firms and corporations have executed **299 contracts covering 769 Murphy Stokers**—299,825 H.P.

For January, February, March and April, 1917, 31 REPEAT ORDERS, 74 STOKERS—24,800 H.P.

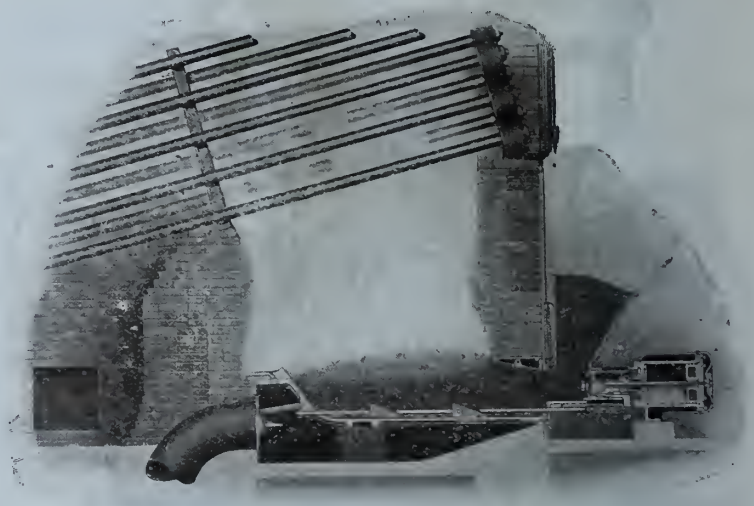
47 REPEAT ORDERS from Canadian users of **MURPHY STOKERS**.

MURPHY IRON WORKS, BUFFALO, N. Y. DETROIT, MICH.

Don't Ponder

Save Money by Coming to a Quick Decision in Favor of

Jones Underfeed Stokers



Burns Less Coal and Cheaper Coal

Delay means lost money and it's not a ponderous question—it's **easy** to see the big advantage of installing a facility that will make a saving in fuel bills amounting to at **least 15% and often 25%**. Jones Stokers are doing it in every line of industry and they can do it for you.

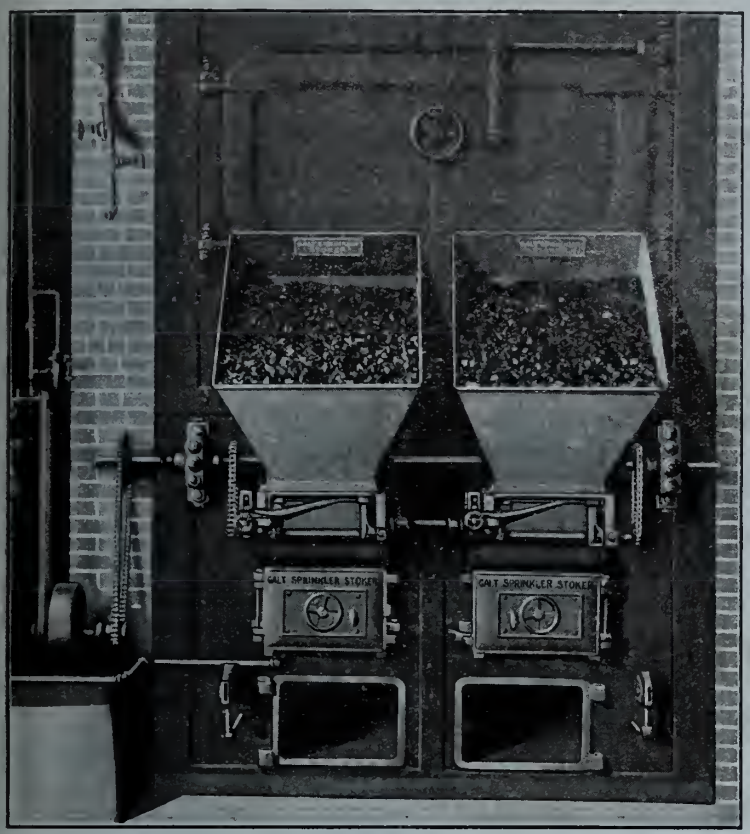
Simple in construction but thoroughly efficient. No complicated parts to cause trouble. **No grates to lose coal through.** They respond instantly to load fluctuations and automatically maintain a uniform steam pressure.

If you are up against smoke regulations, the Jones Underfeed Stokers will keep you always within the law. Let us tell you all about them.

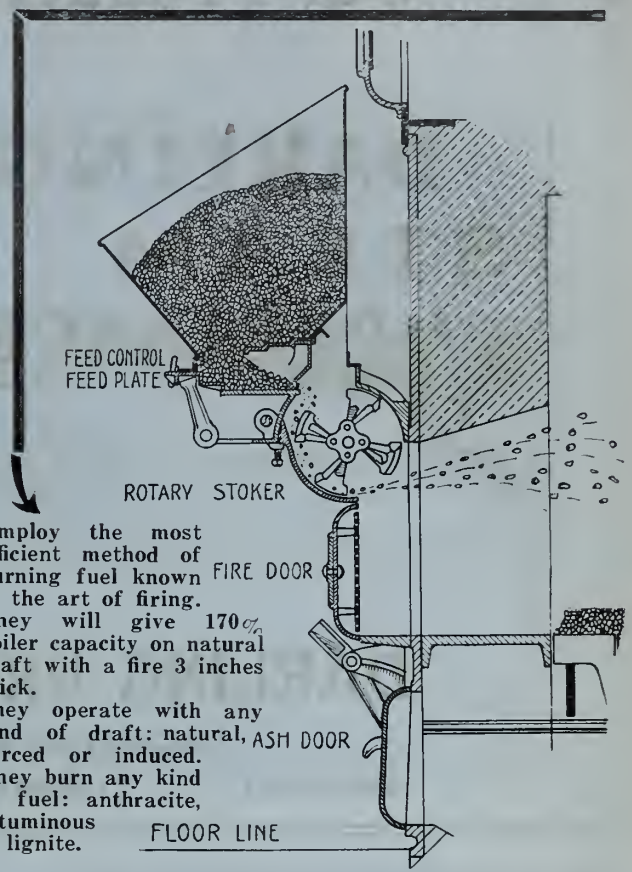
JONES UNDERFEED STOKER COMPANY, LIMITED
37-41 Britain Street, TORONTO,

If any advertisement interests you, tear it out now and place with letters to be answered.

GALT SPRINKLER STOKERS



Two Type "A" Galt Sprinkler Stokers applied to 150 H.P. Return Tubular Boiler.
(Coal Hoppers immediately removable.)
Cost less than half of other stokers. Ask for prices.



Employ the most efficient method of burning fuel known to the art of firing.
They will give 170% boiler capacity on natural draft with a fire 3 inches thick.
They operate with any kind of draft: natural, forced or induced.
They burn any kind of fuel: anthracite, bituminous or lignite.

The Stoker mechanically feeds and perfectly spreads the fuel over the entire length and width of your present grates with the fire doors closed.

What Galt Stokers REALLY DO—

(1) Effect a saving in coal from 10% to 20%.
(2) Effect a saving in labor from 25% to 50%.
(3) Give a thin, brilliant, and perfectly level fire.
(4) Give smokeless combustion.
(5) Increase the boiler capacity greatly.
(6) Increase the percentage of the CO_2.
(7) Burn the fuel completely to finest ash.
(8) Operate for years without need of repair. And other important points.

We supply Power-Turbo Blowers, McNaughton Rocking Grates, Damper Regulators and other Power Plant Equipment.
Ask for our illustrated catalogues on Stokers, Grate Bars, etc., etc.

THE GALT FOUNDRY CO., GALT, ONT.

ALBERTA
W. J. Yeo & Co.
210 McLeod Block, Edmonton

MONTREAL
Ross & Greig
412 St. James Street

HAMILTON, ONT.
D. Turner
110 Lister Chambers

THOMAS ELLIPTIC GRATE BARS—

SHAKING
CIRCLE
STATIONARY

Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

Our Products Made us Known

Our organization, which is one of the largest of its kind on the continent, has reached its present proportions through the quality of our product and our ability to solve and remedy power plant troubles.

If you have any problems, put them up to Darling Brothers, Limited. Our long experience makes problem-solving easy for us.

We can supply almost everything that is needed in the power plant.

DARLING BROTHERS LIMITED

ENGINEERS AND MANUFACTURERS

MONTREAL TORONTO WINNIPEG VANCOUVER

Bundy Steam Traps

When you get heat into water, keep it there! Keep it there and hold it there as long as possible, no matter where the water goes. This is the idea which the makers of the

BUNDY
STEAM TRAPS

have been driving home to power plant men for years.

BUNDY STEAM TRAPS
combine Power, Simplicity and Efficiency

Nashua Machine Company

Manufacturers

Nashua - New Hampshire

Canadian Sales Agents:
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto.

MASON
Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company

BOSTON, MASS.

IN CANADA
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto.

Mention this paper when writing advertisers. It will identify the proposition about which you require information.

WHY

worry because you cannot keep up steam pressure

WHEN

it is so easy and cheap to overcome your difficulties by installing a

COPPUS TURBO BLOWER

It means constant steam pressure, regardless of uneven loads, poor draft and poor coal, and it will pay for itself in a short time on account of better combustion. It also will increase your boiler capacity to 200, and even 300%, of its normal rating without injury to the boiler. Cut out this Ad., put your name and address on the margin and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

In boilers equipped with Coppus Turbo Blowers in four years. The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company

167 Union Street, Worcester, Mass.

Canadian Sales Agents:

The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto.

Announcement

It is barely two years since we occupied our big new plant. Yet the greatly increased facilities then placed at our command have been taxed to their utmost capacity. Hence, we have again been confronted with the problem of an additional increase of our manufacturing capacity.

In a measure, we anticipated this generous support of our many friends, and have been making preparations accordingly.

To-day, therefore, we are pleased to announce that we are now prepared, by added facilities to accommodate a substantial increase in production, and therefore solicit a larger share of your requirements. We take this opportunity of thanking you for past patronage, and look forward with pleasure to a continuance of same.

THE
Schaeffer & Budenberg
MFG. CO.
Brooklyn, N.Y.

St. Louis, Philadelphia
Los Angeles, Pittsburgh,
Chicago, Washington

BAWDEN
NEVER SHORT STROKE
PUMPS

BAWDEN

General Service Pump

NO Tappets. NO External Valve Gear Levers or Springs. NO Internal Tubes or Stuffing Glands.

Construction is of very best throughout.

The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

Drop a card for full particulars.

The Bawden Machine Co., Ltd.

133 Sterling Rd., Toronto, Canada

Agents for Quebec Province:

The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
380 St. James Street, Montreal, P.Q.

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of paying for themselves in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps no adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

CANADIAN *Sirocco* COMPANY
LIMITED

WINDSOR. ONTARIO.

SALES OFFICES:

Canadian Sirocco Co., 526 Traders Bank Bldg., Toronto. Phone Main 5118.
A. M. Nichol, McGill Bldg., Montreal.
S. S. Clarke, 605 W. Second St., Calgary.
W. W. Hicks, 567 Banning St., Winnipeg.
Canadian Sirocco Co., Ltd., 604 Credit Foncier Bldg., Vancouver.

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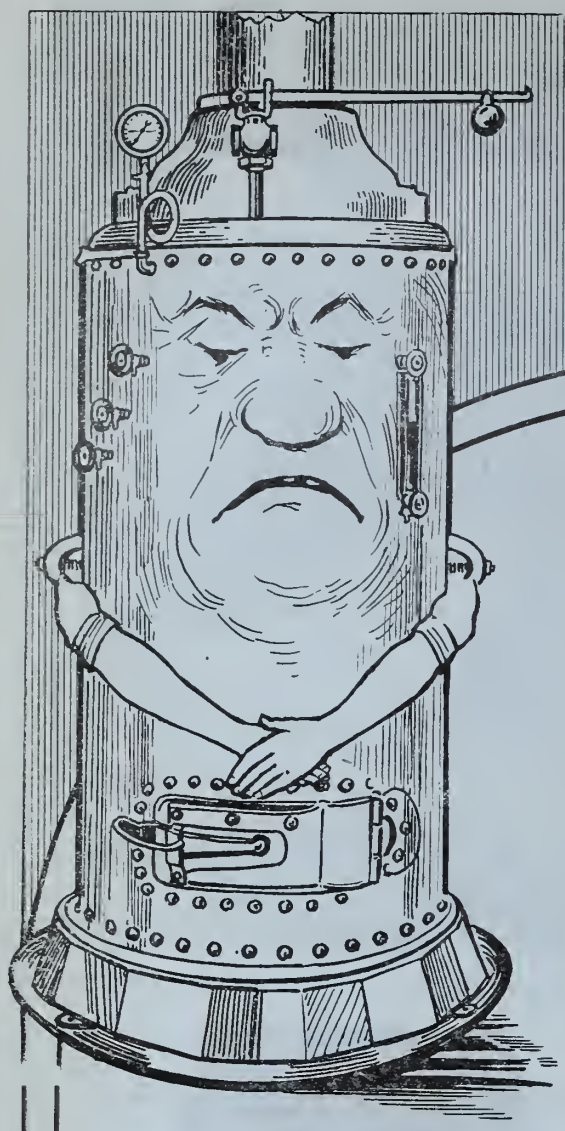

What's the Matter?

If your boilers could talk—
this is what they'd say:

"Why, Boss, my digestion is getting worse every day—my vitality is ebbing. I know you meant well by feeding me with those cure-all boiler compounds, but the blamed dopes have done me no good. Better call in a Specialist or I'll be a gonner before long."

We are Specialists

in that we seek definite information by dealing with each case of boiler trouble separately, locate the cause, and treat it as a skilled physician would human ailments.

Every Barrel of

DEARBORN FEED WATER TREATMENT

that leaves our Works, is made to counteract the troublesome elements which a thorough analysis of the feed water has shown to exist at the plant for which it has been prepared.

Send us a gallon of your boiler feed water for analysis and let us advise regarding treatment for your plant. It costs you nothing for consultation and WE POSITIVELY GUARANTEE A CURE if we accept the case after a careful analysis.

Dearborn Chemical Company of Canada, Limited
1220-30 Dundas Street, Toronto, Ontario, Canada

JOHNS-MANVILLE
Service to Power Plants

Increasing Power Output— by Reducing Friction

TO the engineer the very names "packing" and "stuffing-box" tell an interesting story. The sole function of rod packing is to prevent leakage. Until recently this has been accomplished, for a time at least, by filling the stuffing-box solidly with packing, screwing up the gland or allowing the packing to expand until its pressure on the rod was sufficient to hold back the steam or liquid attempting to escape.

This prevented leakage—but it cost money in three directions: heavy wear on packings, wear of the rod, and loss of power through friction. And the last is especially important if you consider that every foot-pound of energy consumed in plant operation directly reduces the surplus of power available for sale or for factory use.

So we set out to reduce friction and wear of rods and packings at no sacrifice of steam-tightness—and by solving the problem we have inaugurated a new era in "Stuffing-Box Engineering."

Johns-Manville Sea Rings are automatic and active, instead of inert. The pressure of the fluid against the packing holds the lip of the ring tight against the rod—and when pressure falls off or is on the opposite side of the piston, the packing relaxes and permits the rod to move freely. So friction is saved, and power—and the wear on packing and rod is less.

And Sea Rings are but one item in the standardized list of Johns-Manville Packings—a packing for every requirement. Each Johns-Manville Packing is different—with a sound engineering reason for the difference. They're designed to *wear*, and to save money and power—and we back each one to the limit.

You can prove it for yourself by investigation, almost anywhere, or by test—and we'll be glad to help you.

THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED

Toronto Montreal Vancouver Winnipeg

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LOW UNIFORM TEMPERATURES

Are required at some point by most manufacturing processes.

WHERE THESE ARE REQUIRED

It is most important that they should always be obtained easily and consistently,—that means

QUALITY REFRIGERATING EQUIPMENT

We always believed quality pays, we feel our satisfied customers prove it.

THE LINDE CANADIAN REFRIGERATION CO, LIMITED

37 ST. PETER ST. MONTREAL

Established and Manufacturing in Canada since 1896.

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones. AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada.

CORLISS and POPPET VALVE ENGINES.

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

We Are Prepared

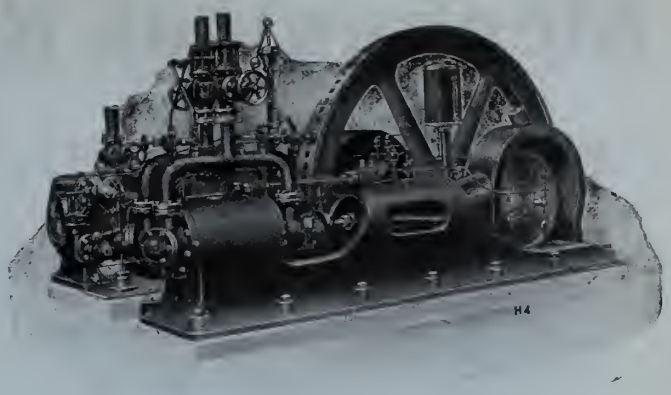
The **Longest** and **Hottest Summer Seasons** have no terrors for a

"FRICK"

MAXIMUM Economy-Endurance

MACHINE

Ask the man who owns one.



They **go** and **keep going** under the most severe duty, with an assurance of long life and lowest possible upkeep cost.

Write us any time and any place.

Frick Company

WAYNESBORO, PA. U.S.A.

ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives: The Frick Ice & Refrigeration Co., Montreal, Canada

Top floor of Sun Packing Company's building, Pittsburgh, Pa., after the fire.

Is Nonpareil Corkboard Fire-Retarding?

One glance at the accompanying illustration will answer this question.

Last spring the plant of the Sun Packing Company, Pittsburgh, Pa., was visited by fire. So intense was the heat that practically everything on the top floor was destroyed except portions of the brick walls and the cooler, which was insulated with

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

Notice how the outside sheathing was carried all the way through and in some cases consumed completely. Notice, too, how the action of the flames was stopped as soon as the Nonpareil Corkboard was reached. Aside from a slight charring the corkboard showed no evidence of having been through a fire. This instance is not an unusual one. Nonpareil Corkboard has been tried by fire many times, and in each case its fire-retarding properties have been demonstrated conclusively.

Full information and sample on request

Armstrong Cork & Insulation Company, Limited

504 McGill Building, Montreal, Quebec

Also manufacturers of Nonpareil Cork Covering for all cold pipes and Nonpareil High Pressure Covering for steam lines, feed-water heaters, etc.

If any advertisement interests you, tear it out now and place with letters to be answered.

Mechanical Refrigeration

In the application of Mechanical Refrigeration in the various trades, we can be of real service to prospective users in suggesting Refrigerating Equipment that will meet the conditions most efficiently and economically.

Our Engineering Department, which is constantly in touch with these problems, is at the service of any one contemplating the use of Mechanical Refrigeration.

Our recommendations are made without prejudice, as we are prepared to furnish the type of Plant best suited to meet the conditions involved.

We invite correspondence on any subject pertaining to the application of Mechanical Refrigeration.

YORK MANUFACTURING COMPANY

Ice Making and Refrigerating Machinery exclusively

YORK, PA.

REPRESENTED IN THE DOMINION BY

CANADIAN ICE MACHINE COMPANY

MONTREAL, 626 Corlstine Building. TORONTO, 82 Chestnut Street. WINNIPEG, 85 Lombard Street.

DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because :

1st—Only the best materials are used in their construction.

2nd—We use heavier materials. Result: Longer life and increased efficiency.

3rd—Our doors are built with double and triple seals of contact—others have but one.

4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.

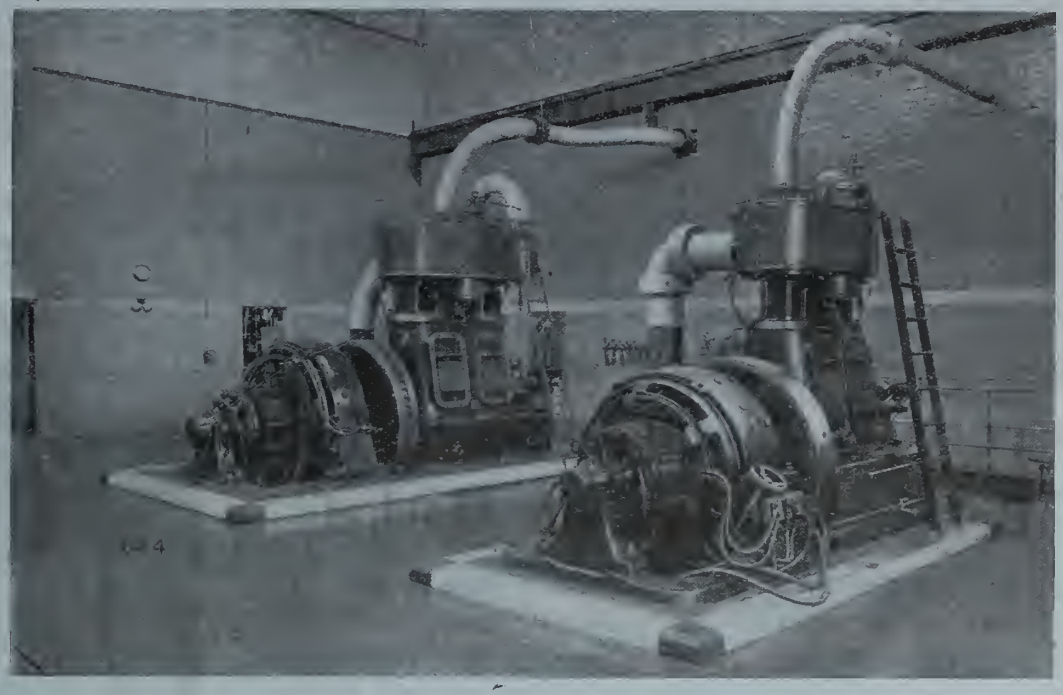
5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. **HAGERSTOWN, MD., U.S.A.**

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: **MONTREAL**

If any advertisement interests you, tear it out now and place with letters to be answered.

"That's by Far the Best Belting Value on the Market"

It's not cheapest because it cost less in the first place, but rather because of the good and lengthy service it gives. You are assured of the smallest possible amount of slippage and fewest number of breaks with—

D. K. McLaren's

GENUINE BRITISH OAK TANNED

Leather Belting

There's practically no stretching. These belts require so little attention and give such perfect service that the time, labor and money saved in the course of a year amounts to large proportions.

Only flawless back leather is used and our genuine British Oak Tanning Process preserves every bit of the hide's natural strength.

D·K·McLAREN LIMITED

HEAD OFFICE AND FACTORY:

351 ST. JAMES STREET, - MONTREAL, P. Q.

TORONTO, ONT. 194 King Street West
ST. JOHN, N. B. 90 Germain Street
VANCOUVER, B. C. 847 Beatty Street

ECONOMY **UNIFORMITY**

AMACOL
TENAXAS
TIN TOUGHENED
ATLAS
MASCOT
W. E. W. BABBITT

THIS RANGE OF
ATLAS BABBITTS
WILL MEET ANY OF
YOUR DEMANDS
AND **SATISFY** YOU

ATLAS METAL and ALLOYS COMPANY of CANADA, Limited
MONTREAL

Sales Agents :

The Canadian B. K. Morton Co., Limited

MONTREAL
49 Common Street

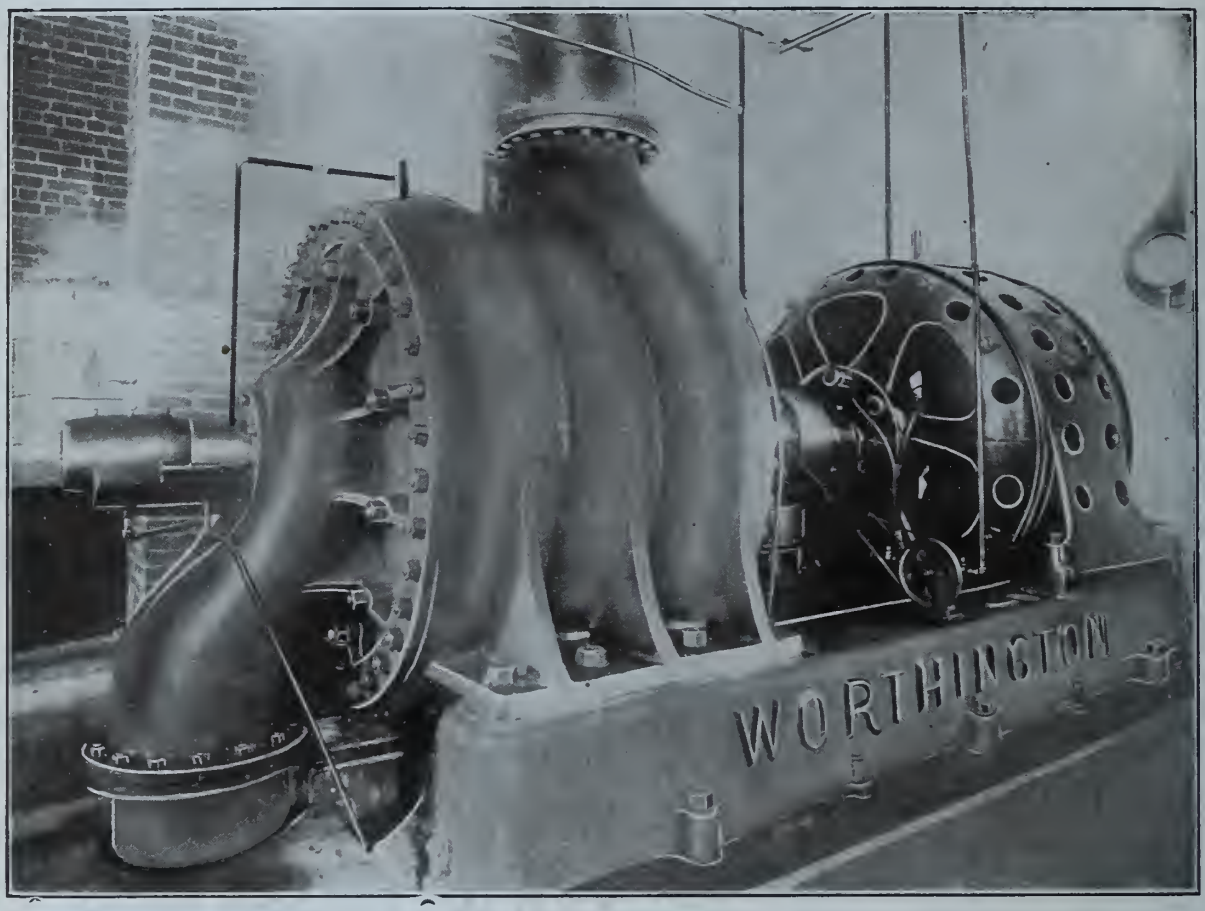
TORONTO
86 Richmond Street East

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works: Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO July, 1917

OUR JULY NUMBER

The next number of Power House will be something unusual. It will be by far the largest and best issue, in every way that we have ever published.

Annual Equipment *and* Supply Number

At the request of advertisers and readers we have advanced the date of our Annual Number and this year it will be published in July, including, at the same time, the principal features of our customary C.A.S.E. pre-convention Number, Mr. Bain, our editor, has arranged for a very fine programme editorially.

Now that the Graded Certificate system of examining in Ontario is anticipated, a new series of questions and answers, beginning in our July issue, will possess a peculiar interest for Ontario engineers.

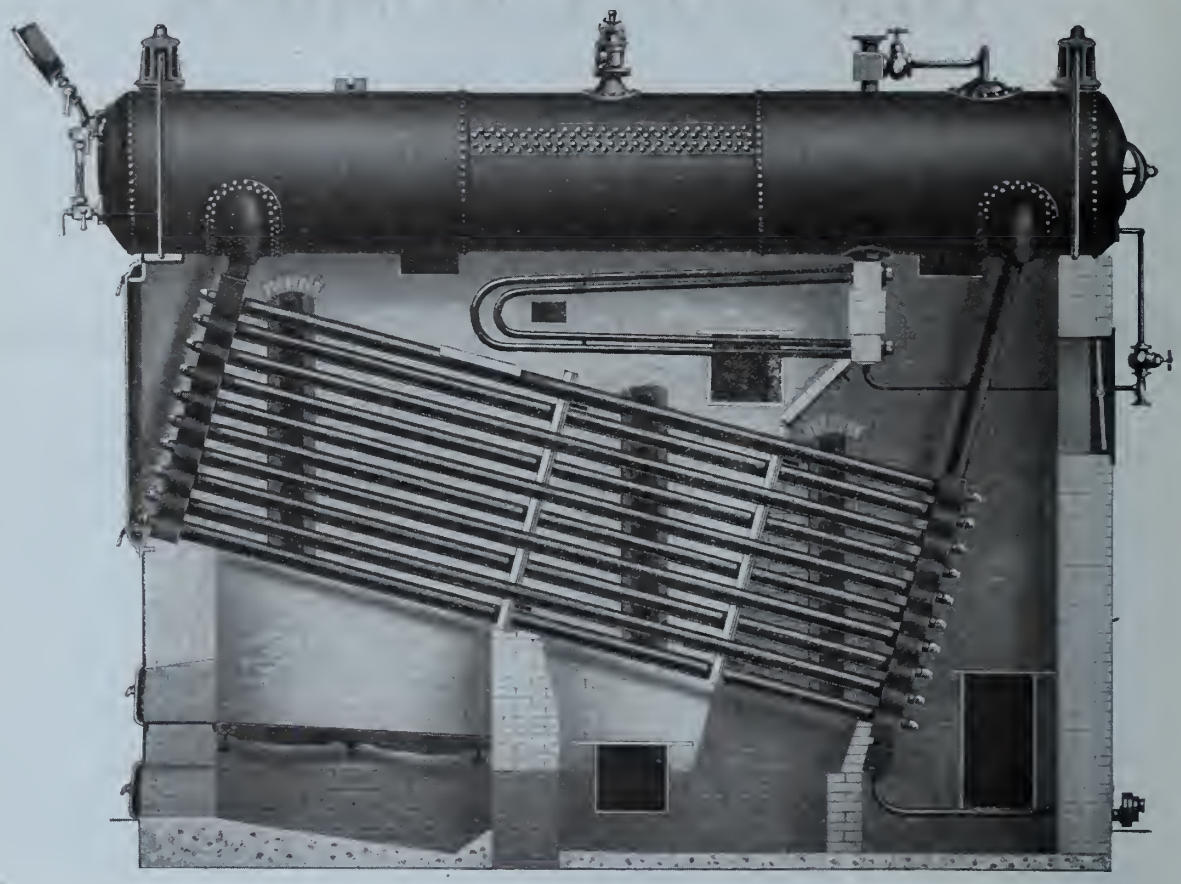
Our July Number will contain an outline of the programme to be followed at the C.A.S.E. Convention, which this year will be held in Toronto.

The advertisements will be unusually interesting and instructive. Many advertisers have arranged for large space and some have already provided copy of a very high order.

THE POWER HOUSE
143-153 University Avenue Toronto, Canada

G. & McC. CO.

BOILERS



Sectional View, Standard Type "B," Sectional Water Tube Boiler, with Superheater.

G. & McC. Water Tube Boilers are fitted with large Steam and Water Drums, connecting nipples of increased size and straight 4" tubes, all of which insure

POSITIVE AND RAPID CIRCULATION, and INCREASED STEAMING CAPACITY

All parts subjected to steam pressure are made of FORGED STEEL

G. & McC. Engines and Boilers are giving satisfaction in thousands of Canada's leading industrial institutions. Write us for prices, plans, specifications, etc.

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

Merits of Some Recent Developments in Air Pump Design*

By E. Jones

In this paper there are discussed the merits of some of the more recent developments pertaining to a piece of equipment installed in most power stations. An air pump is a very essential part of the condensing plant, without which any of our modern steam-operated power stations or, indeed, any machines used for the generation of power, employing steam as the working fluid, would be practically of no value except for very small units.

IT may be advisable at the outset to run very briefly over the various types of condensing plant at present in use, in order to arrive at the cause of inventors turning their attention to the design of new types of air pumps. There are five types of condenser, viz., evaporative, ejector, barometric, jet, and surface.

Evaporative Condenser

Evaporative condensers are expensive because of the large cooling surface re-

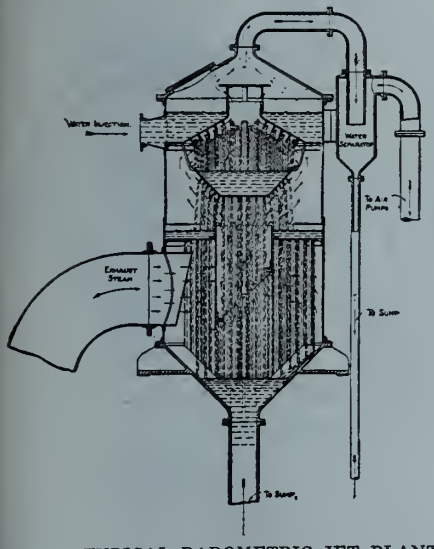


FIG. 1. TYPICAL BAROMETRIC JET PLANT.

quired to condense the steam, and are only adopted when it is almost impossible to obtain water which can be utilized for cooling purposes. Steam flows inside of the tubes, which are grouped together in sections, and all joined up to the header pipes or steam mains. Cooling is obtained by air, and the radiation effects caused by allowing a stream of water to continually pass over the tubes. There are a great many joints in the apparatus which tend to make this type of condenser unsuitable for modern requirements.

Ejector Condenser

The ejector condenser deals with the steam and air without the use of an air pump. The steam to be condensed is delivered into the condenser body, which is fitted with a specially designed series of nozzles. The cooling water enters under pressure at the top of these nozzles, condensing the steam and entraining the air and incondensable gases, the whole passing down the discharge pipe. Despite the simplicity of these condensers, they do not appear to have found general favor.

The foregoing types would appear to be still in the embryo stage, and open up large fields for further investigation.

Barometric Condenser

The barometric condenser is, of course, a jet condenser, in which the cycle of operations of the cooling water is just the reverse of the cycle used in the low-level jet plant—that is to say, the cooling water is pumped into the condenser and flows away by gravity down the tail pipe. It is, therefore, necessary to place this condenser at a height above the level of the water in the outlet sump, equal at least to the height of the water column which could be supported by the vacuum plus a marginal head of at least 3 ft. or 4 ft., to allow for pipe friction and to cause flow of the water. This very often means that the condenser has to be placed on the top of a building, or on a staging specially erected to accommodate it at the required height. Occasionally cases crop up where a barometric plant can be installed at the ground level of the engine room, but this means that the cooling water is at a level of at least 34 ft. below, and, therefore, if the pumping plant is of the centrifugal type, it is necessary to have a pump house considerably nearer the cooling water level, which means that the plant is not compact or self-contained. This is a decided disadvantage. Another point which does not tend to add favor to the barometric plant when placed at a distance above the exhaust branch of the prime mover is the long length of exhaust steam main,

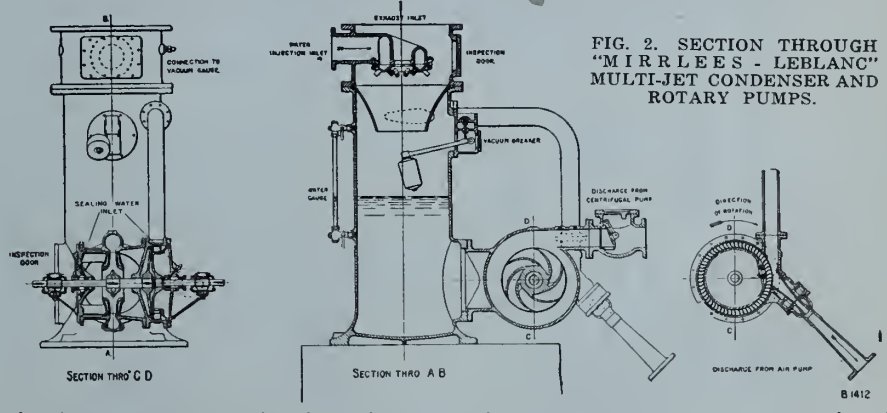


FIG. 2. SECTION THROUGH "MIRRLEES - LEBLANC" MULTI-JET CONDENSER AND ROTARY PUMPS.

which is not only expensive, but often a source of trouble, due to the greater number of joints, which have to be kept perfectly air-tight.

Low Level Jet and Surface Condensers

It is chiefly for these reasons that the barometric jet-condensing plant has been superseded by the low-level jet plant. At the present time the majority of condensing installations are either of the jet or surface type, and the choice generally depends on local conditions and sometimes by the amount of money available for the scheme on hand. With the low-level type of jet plant, the cooling water is drawn into the condenser which is under vacuum. The water and steam mix freely, and the latter is condensed, and the cooling water and condensate are extracted from the condenser by means of a pump which is invariably, as far as the writer's experience goes, of the centrifugal type, specially designed to meet the requirements of drawing water from a space under a very low absolute pressure and discharging at atmospheric pressure or against an external head. The air and gases which are not liquefiable under the conditions obtaining in the condenser, are dealt with by some type of dry air pump. The advantages of this type of plant over the barometric jet plant are that it can be placed immediately below the turbine, thereby reducing the possibility of air leaks. The whole equipment is self-contained and compact, and can be operated and regulated at very short notice by the engine-room attendant. Fig. 1 and 2, show a typical barmetric jet plant and low level multiple jet plant of the Leblanc type.

Surface Condenser for Marine Work

Perhaps the most important type of condensing plant is the surface condenser, inasmuch as it is used almost invariably for marine installations, and in a lesser degree for large power units, the reason for this being that the condensate is an important item, as it supplies a source of excellent boiler feed-water and also under the same external conditions, the power required to operate a surface condensing plant is generally less than for a jet plant. The design of modern

*From a paper read recently before the Institution of Engineers and Shipbuilders, Glasgow, Scotland.

surface condensers, as far as the condenser itself is concerned, has not changed materially for the last 30 years or so, so that there is no need to go further into details on this point. The cooling water is usually supplied by means of a centrifugal pump, except in cases where a syphonic action can be utilized or where the existing pumping plant is capable of taking care of the requirements of the condenser. A condensate pump is necessary to deliver the condensate from the condenser to the boiler feed-tank, and a dry air-pump to deal with the air and unliquefiable gases which find their way to the condenser. Alternately, an Edwards air pump can be adopted to deal with both the condensate and air If the disposition of the various parts of the installation demand it, a hot-well will also be required. The above table may be of interest in noting the relative costs and requirements of the last three types of condensers which have been considered.

Type of plant.	Consisting of—	Approximate net weight of apparatus.	H.P. required to drive condenser and auxiliaries.	Present day costs.	Equivalent ratio.
Barometric.	Condenser, staging, air-pump, injection pump, driving motor, switchgear, air and tail piping, main-exhaust piping and sluice valve, auto-exhaust valve. Complete erection.	40 tons.	89 B.H.P.	£2,700	1·286
Low-level jet.	Condenser, water-extraction and air-pumps, driving motor, switchgear, main sluice-valve, adapting and expansion pieces, auto-exhaust valve. Complete erection.	22 tons.	87 B.H.P.	£2,100	1·00
Surface.	Condenser, rotary air-pump, extraction pump and circulating pump mounted on common bedplate with driving motor and switchgear. Necessary interconnecting pipes, main exhaust steam-sluice-valve, expansion piece, adapting piece, automatic atmospheric-valve. Complete erection.	30 tons.	78 B.H.P.	£3,300	1·571

FIG. 2a. RELATIVE COSTS AND REQUIREMENTS OF THE FOREGOING THREE TYPES OF CONDENSERS.

The conditions which have been assumed are the same for each case, and are as follows:—Steam quantity 40,000 lbs. per hour, vacuum 28½ inches (barometer 30 inches)—95 per cent. of the barometer, cooling water 60 deg. Fah., prime mover, high pressure steam turbine. For the barometric plant, .25 inch has been added to the vacuum to allow for the drop between the turbine-exhaust flange and the condenser. It should be noticed here that under the present abnormal conditions, surface condensers are in a practically unfortunate position, owing to the cost of the materials used for the tubes and tube plates, which is approximately 27½ per cent. of the value of the whole equipment. The price of tubes to-day is 38 cents per lb., whereas, in 1914, just prior to the commencement of the war, the price was 15 cents per lb., so that the increase in the cost of tubes is 240 per cent., and the increase in the cost of plates is approximately the same. Therefore, if times were normal, surface-condensing equipment would appear in a much better light, and although it is not proposed to suggest an accurate figure for surface plant with tubes at 15 cents, it is clear that a reduction of from $2,500 to $3,000 should be possible in the case given above. This would bring the cost ratio of the surface plant, when compared with a multi-jet plant, from 1.57 to about 1.3.

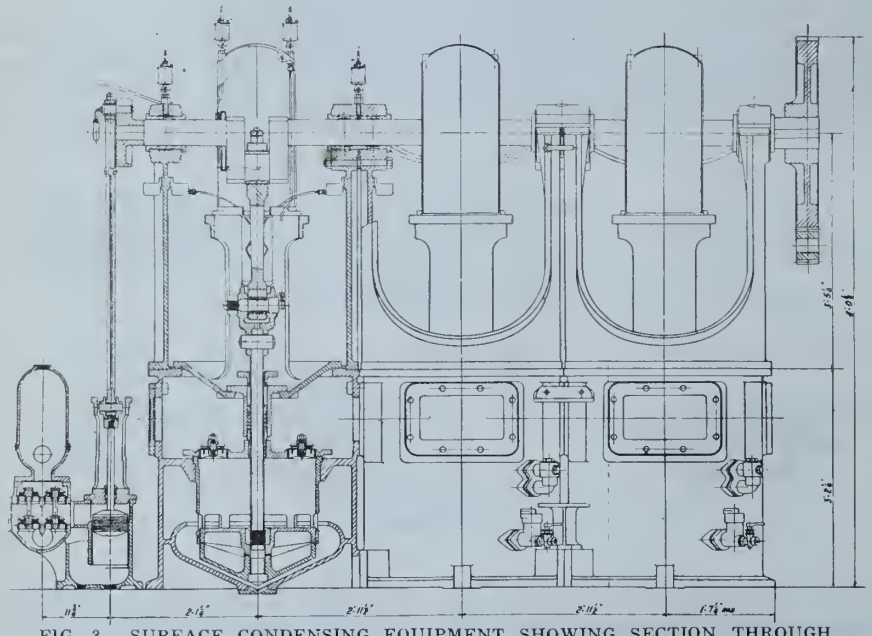


FIG. 3. SURFACE CONDENSING EQUIPMENT SHOWING SECTION THROUGH "EDWARDS" AIR PUMP.

With the earliest types of surface condensing equipment, it was usual to use one pump for removing both the condensate and air from the condenser. This pump was known as a "wet" air pump, and a good example of this type is the Edwards air-pump, one of the most efficient of its class. It is shown in section in Fig.3. The chief advantages of this type of pump are:—Low power required for driving; positive action and consequent stability; ability to cope with excessive air leakages. While the Edwards pump is still an excellent pump for units up to say, from 3,000 to 4,000 k.w., it must be remembered that, with the ever-growing size of power units, its disadvantages should be kept in view. For large units with Edwards pumps, it is necessary that they should run at a very low speed, and consequently they are very cumbersome, and take up a large amount of floor space. With jet plants, the Edwards pump is sometimes used as a dry air-pump. It is necessary, of course, to provide a small quantity of water for sealing purposes. Volumetric efficiency in this pump varies considerably with the degree of vacuum required, and decreases as the vacuum increases from about 50 per cent. at 3½ inches absolute pressure to 18 per cent. at 1 inch absolute pressure.

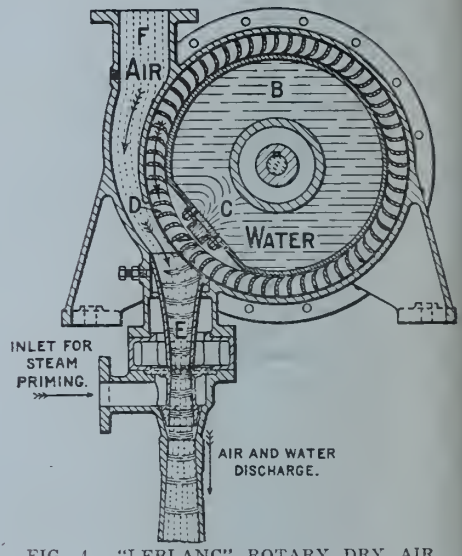


FIG. 4. "LEBLANC" ROTARY DRY AIR PUMP.

Dry Air Reciprocating Type Pump

Another system is that in which a dry air-pump of the reciprocating type is used to remove the air and uncondensed gases, and a separate pump to remove the condensate. The advantages and disadvantages of this system are the same as for the Edwards air pump, but the efficiency is rather better. Previous to the introduction of the steam turbine, condensing plant equipments were furnished with air pumps of one or other of the types mentioned above, but as soon as the turbine became a commercial pro-

position, it was necessary to look for a type of pump having features specially adapted to its requirements. With turbine installations, it is essential to use a high vacuum in the condenser, whereas

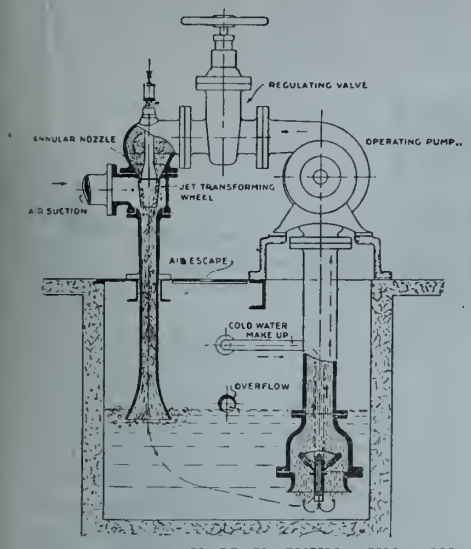


FIG. 5. HYDRAULIC VACUUM PUMP ON EJECTOR PRINCIPLE.

with steam engines of the reciprocating type a vacuum of more than 26½ inches was seldom required. In fact, it is questionable whether using a higher vacuum than 26½ inches would not be considered a disadvantage. With the turbine, however, a vacuum less than 27 inches is rarely asked for, and sometimes the specified figure is as high as 29.25 inches with the standard barometer reading of 30 inches.

In considering these figures, due allowance must be made for the altitude of the place. The most economical vacuum for a turbine installation depends on a variety of things, and each case has to be considered on its merits. On reference to steam tables it will be seen that an increase in vacuum from 27 inches to, say, 29 inches, other conditions as air leakage remaining the same, necessitates an increase in the capacity of the air pumps from 1.00 to 3.25, which for a large installation with Edwards or reciprocating dry air pumps is a very serious

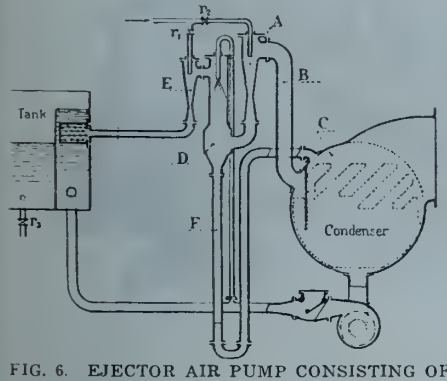


FIG. 6. EJECTOR AIR PUMP CONSISTING OF TWO EJECTORS WORKING IN SERIES.

matter. Hence it is that various types of rotary pumps, which are specially suitable for dealing with large volumes of air at low tension, have been designed since the adoption of the steam turbine, several of which have proved very successful. The general design of these pumps is much the same, in so far as they use a certain quantity of what is termed "operating water," for which various devices have been invented to cause this water to move in such a manner as to entrain the air from the condenser and discharge it to the atmosphere.

Leblanc Rotary Dry Air Pump

Perhaps one of the best known rotary dry air-pumps is the one invented by Prof. Maurice Leblanc. It has been used to a very large extent all over the world and its action is shown in Fig. 4. This pump is capable of maintaining a very high vacuum, and for this reason, coupled with the fact that it is very simple in construction and not likely to get out of order, it has been largely used

The power required to drive these pumps is rather higher than that required for an Edwards or other good type of reciprocating air-pump, and consequently a good deal of attention has been paid recently to another type of pump which would incorporate the simplicity and compactness of the rotary pump and the low-power consumption of the Edwards and other reciprocating pumps. The general trend of thought seems to have been in one direction, and there are now on the market, and in commercial use, air-pumps operating on the ejector principle. Nearly all the leading condenser manufacturers now construct air-pumps of this description.

Worthington Hydraulic Vacuum Pump

The Worthington Pump Co. manufacture a patent hydraulic vacuum pump on

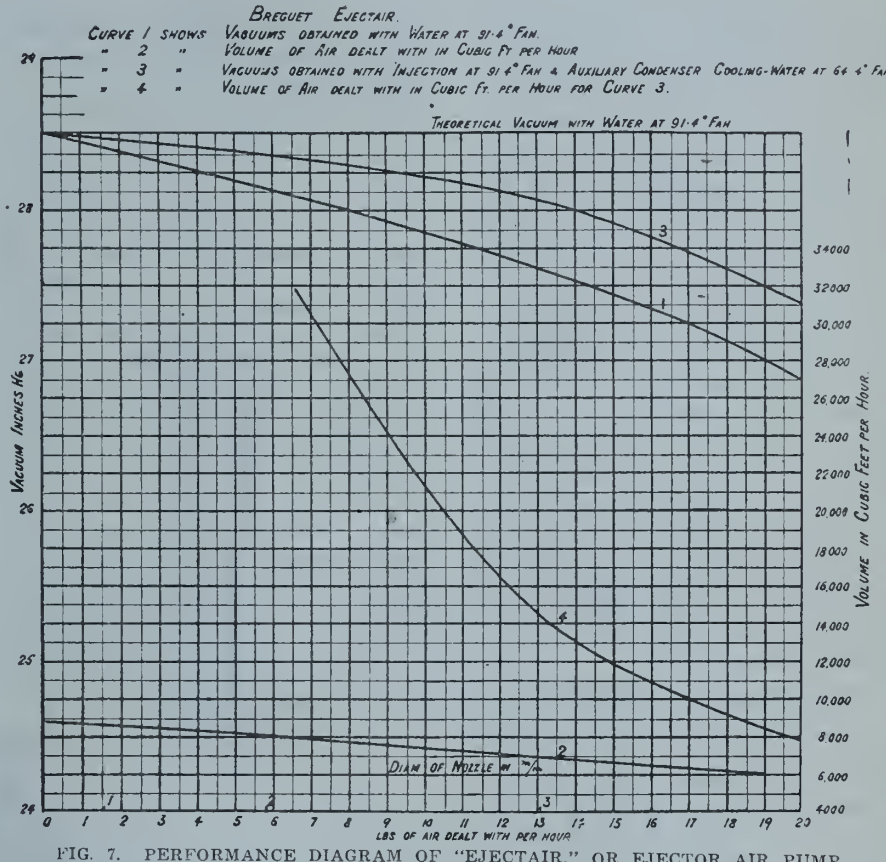

BREGUET EJECTAIR.
CURVE 1 SHOWS VACUUMS OBTAINED WITH WATER AT 91·4° FAH.
" 2 " VOLUME OF AIR DEALT WITH IN CUBIC FT PER HOUR
" 3 " VACUUMS OBTAINED WITH INJECTION AT 91·4° FAH & AUXILIARY CONDENSER COOLING-WATER AT 64·4° FAH
" 4 " VOLUME OF AIR DEALT WITH IN CUBIC FT PER HOUR FOR CURVE 3.
THEORETICAL VACUUM WITH WATER AT 91·4° FAH.
VACUUM INCHES Hg
VOLUME IN CUBIC FEET PER HOUR
DIAM OF NOZZLE IN INS
LBS OF AIR DEALT WITH PER HOUR

FIG. 7. PERFORMANCE DIAGRAM OF "EJECTAIR," OR EJECTOR AIR PUMP.

for turbine installations. It cannot be claimed for this pump—or indeed for any type of rotary air-pump—that it can successfully deal with an excessive air leakage, but consideration will show that this quality is not essential in the case of turbine installations where air leakage is reduced to a minimum by the adoption of steam or water-sealed glands where the shaft passes out of the turbine casing. With a surface-condensing plant, it is only possible for air to be brought into the system by the feed-water and carried over with the steam, or by leaking in at the joints. With jet plants, the air brought in with the injection water has to be allowed for in addition to the above, and it is for this reason that the air-pump on a jet plant requires to be larger than that for a surface-condensing plant doing the same steam duty.

the ejector principle, as illustrated in Fig. 5, which consists of the injection head, the air - suction chamber, the rotary wheel, and the throat and tail pipes. The operating water passes between two nozzle rings, and the cone of water passes between the body of the wheel and the outer sleeve, impinging on the inclined surfaces of the vanes, thus imparting a rotary motion to the wheel. To operate the pump, it is necessary to provide a certain amount of sealing water, which is supplied from a tank situated as convenient as possible to the pump. The sealing water takes up a certain amount of heat from the air and water vapors withdrawn by the air-pump, and a piping arrangement is provided for withdrawing a certain amount of this water by means of a by-pass connection on the operating pump discharge,

this by-pass being fitted with a controlling reflux valve. The quantity of water withdrawn in this manner is replaced by make-up water drawn from the circulating inlet piping or an independent supply, thus cooling the water used in the cycle of operation. This apparatus is doing regular service on one of the turbo-alternator groups at the Glasgow Corporation power station at St. Andrew's Cross. A number of installations have also been supplied to other concerns.

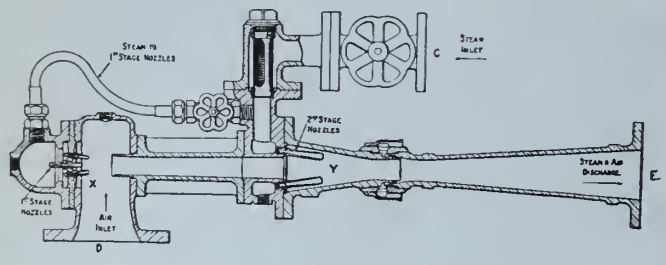


FIG. 8. "LEBLANC" EJECTOR AIR PUMP—SECTION 1.

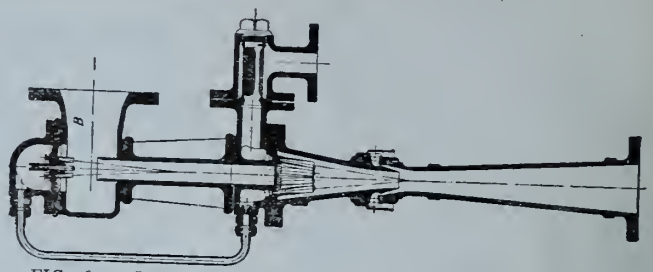


FIG. 9. "LEBLANC" EJECTOR AIR PUMP—SECTION 2.

Willans-Muller Ejector Air Pump

Willans & Robinson, of Rugby, manufacture the Willans-Muller ejector air-pump, which is operated by the circulating water, either on the series or shunt system. With the series system, the whole of the circulating water passes through the ejector before entering the condenser. With the shunt system, only a portion of the cooling water passes through the ejector, which, after use, is returned to the pump suction or the source of supply. A third method of operating this ejector is by the separate pump system, in exactly the same manner as described with reference to the Worthington pump. The Glasgow Corporation have a set of this apparatus at work at Pinkston Power Station, and good results have been obtained, and a second set is just being installed at St. Andrew's Cross.

Hick, Hargreaves "Ejectair"

Another type of ejector air-pump is that manufactured by Hick, Hargreaves & Co., Bolton, under license from the Maison Breguet, Paris, which is really two ejectors working in series with an auxiliary condenser placed between the first and second stage of the ejectors. A number of these air-pumps, termed "Ejectairs," have been supplied or are under construction for the French navy. Referring to Fig. 6, it will be observed that the primary ejector is placed in direct communication with the main condenser, and extracts the aerated vapor, being operated by a single steam jet or nozzle. The mixture of steam and partly compressed vapor is then discharged to the auxiliary condenser, and the water returned to the main condenser to be dealt with by the extraction pump. The second stage ejector is coupled up to the auxiliary condenser, and draws the air away, discharging it to the feed-tank. An automatic air-inlet valve is fitted to the auxiliary condenser, to regulate the absolute pressure therein. It is claimed that taking air from the atmosphere in this manner materially assists the stability of the plant, and also renders it more flexible.

These ejectairs are designed for working with steam pressures at 55 lbs. per square inch or above, and, with a special arrangement of nozzles, lower pressures can be used in the primary ejector, although the advantage of this is not apparent if it is impossible to work the other ejector under the same conditions, neither is it clear whether this can be accomplished or not.

The curves, Fig. 7, show the performance of an ejectair. Steam to the ejectors had an absolute pressure of 125 lbs. per square inch, and the steam consumption is given as 194 lbs. per hour, of which 129 lbs. are recoverable. The apparatus, worked in conjunction with a small jet condenser, dealing with 94 gallons of injection water per minute.

Curve 1 gives the vacuums obtained with water leaving the condenser at a temperature of 91.4° Fah. (33° C.), and the auxiliary condenser out of action; Curve 2 the volume of air dealt with in cubic feet per hour; Curve 3 the vacuums obtained with given air leaks, and the water leaving the main condenser as for Curve 1, but with the auxiliary condenser supplied with cooling-water at 66.2° Fah. (18° C.), and Curve 4 the volumes of air dealt with under the same conditions. It was caluculated that the air coming in with the injection-water and at leaky joints amounted to 1.10 lbs. per hour (.5 kg.).

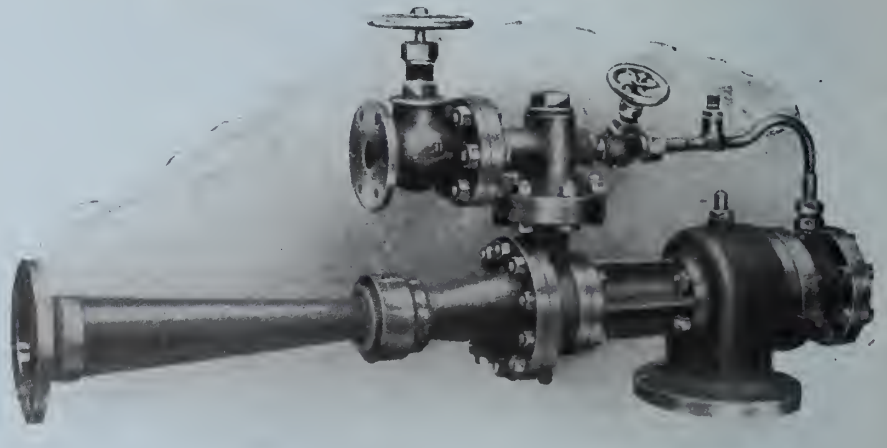


FIG. 10. "LEBLANC" EJECTOR AIR PUMP—EXTERIOR VIEW.

Leblanc Ejector Air Pump

The British Westinghouse Electric & Mfg. Co., Manchester, and Mirriless Watson Co., Glasgow, manufacture an ejector air-pump, under license from the Societe Anonyme Westinghouse, Paris and Le Havre, which is another invention of Monsieur Maurice Leblanc. It is the outcome of many months of arduous research work, during which time innumerable difficulties were surmounted by the inventor, with the result that a really first-class ejector air-pump has been evolved. Figs. 8, 9 and 10 show the general layout of the apparatus.

The pump is arranged to work in two stages, and the steam is admitted to the second stage of the ejector by opening the stop valve. Immediately it is opened, steam fills the annular space behind the nozzle plate, and finds its way into the throats of the group of nozzles attached to this plate; it then passes along the steam pipe which supplies the first-stage nozzles, which are also attached to a nozzle plate. The supply of steam in this set of nozzles is controlled by the stop valve on the steam-supply pipe. The pump is connected to the condenser at the branch, which is the air-inlet branch.

At the entrance to each of the steam spaces, fine wire-gauze strainers are fitted to prevent any foreign matter which may have primed over with the steam from the boilers, from entering the nozzles, thereby intercepting any stoppage in the nozzle throats, and consequently a loss of vacuum. These nozzles are efficiently locked to the nozzle plates. The mixture of air and steam is discharged at the mouth of the divergent cone, and led away to the boiler feed tank, so that the heat units contained in the operating steam can be reclaimed by heating the feed-water. To start the pump to work, it is only necessary to open up the steam valve, and the vacuum will at once commence to increase in the condenser or other vessel to be evacuated. When the vacuum gauge becomes sta-

tionary, the second-stage steam-inlet valve is opened up to bring the vacuum to a maximum. A very important feature in this pump is the absence of moving parts. The simplicity of the apparatus is even more remarkable than that of the Leblanc rotary pump.

Advantages of Ejector Air Pump

The advantages claimed are as follow:—Extreme simplicity; the small amount of energy required for operating purposes; the high efficiency obtained; ease with which starting can be effected, and the small amount of attention required whilst at work; ability to produce the highest possible vacuums; stability. In scanning these claims we can pass over the first, which has already been mentioned and is obvious; there are simply two steam valves to open. The second deserves some consideration. The operating steam in passing through the nozzles decreases in pressure, and consequently in temperature, and also, after passing through the nozzles, does work in accelerating the velocity of the air, increasing its temperature and compressing it. There is also a small amount of heat lost, due to friction in passing through the diffuser portion of the ejector, which might be considered negligible. Beyond this, the whole of the heat in the steam can be utilized to heat up the boiler feed-water, and in order to obtain full benefit from the apparatus, it is highly desirable to use the discharge from the ejector for heating purposes of some description. Thus, both the steam and air can be made to do useful work. In view of this, it must not be forgotten that when an ejector of this type is specified as requiring so many pounds of operating steam per hour, this is only the apparent quantity, the actual quantity is really far less, since the great majority of heat units in the steam are still available for further work. The actual heat units recovered can easily be calculated from steam tables, since it is known that the steam and air leave the ejector at a pressure of from 10 to 12 lbs. per square inch by gauge.

Auxiliary Condenser Not Required

It will be observed that with a Leblanc multijector, an auxiliary condenser is not required, and in this respect it differs materially from the "Breguet" ejectair. The employment of an auxiliary condenser has the disadvantage that the total heat units of the steam used in the first-stage ejector, which amount to an appreciable percentage of the total heat units used on the whole apparatus, are dissipated and lost. The makers give this percentage as about 33. Another reason for dispensing with the auxiliary condenser will be apparent from the following:

In all steam-operated ejectors, one of the difficulties that have to be contended with is the fact that the steam leaves the nozzles at a velocity varying from about 3,000 to 3,600 feet per second, while the velocity of the fluid to be entrained is practically nil. This is the cause of considerable loss of efficiency in any ejector, but if an auxiliary condenser is used, the defect is doubled, because the velocity of the fluid to be entrained, which has been imparted to it by the operating steam during its passage through the first-stage ejector, is dissipated and lost as soon as it enters the condenser. The cooling water used on the auxiliary condenser has to be dealt with by the condensate pump, thus increasing the power absorbed by the plant. When working with surface condensers this water must be of good quality, as it has to be returned to the boilers.

The third claim relates to efficiency. It is well known that ordinary single-stage

FIG. 11. STEAM NOZZLE DIAGRAM.

ejectors only work well when the compression ratio is as 1 : 7, and it is partly for this reason that the Breguet Co. have introduced the auxiliary condenser, so that the vacuum obtaining in this condenser is about 25.6 inches with the barometer at 30 inches, the compression being approximately as 11 : 76, or roughly, 1 : 7. The overall efficiency of this plant is, therefore, apparently still further reduced, because air is admitted from the atmosphere into the auxiliary condenser which is under a vacuum of 25.6 inches, and this, together with the air from the condenser, has also to be ejected by the secondary ejector to the atmosphere.

When Professor Leblanc set out to design his ejector he foresaw the possibility of using an intermediate condenser, but he also appreciated its disadvantages, and decided to do without it if at all possible. At the same time, he knew that it was essential to use two stages in order to get a stable and efficient ejector. With this end in view, certain steam nozzles were designed on the lines of the formulae of Professor Rateau, and the action of the steam issuing from these nozzles when under high vacuum was directly observed. The result is shown by Fig. 11. The steam issuing from the mouth of the nozzle expands and contracts alternately, ultimately assuming a section of constant area. It was found that a number of these nozzles grouped together gave far better results than a single nozzle of the same throat area as the group of nozzles.

Number and Size of Nozzles

The reason for this is to a large extent due to the fact that the alternate increasing and decreasing of the cross sectional area of the steam stream is minimized by the contact of one steam stream with the next, when groups of nozzles are employed, and this helps to considerably increase the surface available for the entrainment of the air and gases. This entrainment is carried on mainly by friction, and it will be seen that if an appreciable amount of gas has to be dealt with the frictional surface exposed to the gas has to be as large as possible. It is also inversely proportional to the density of the gas or fluid. The number and size of the nozzles depends entirely on the space available in the diffuser, and keeping within the limits of workshop practice.

The smallest number employed by the Mirrlees Watson Co. is three, each of which has a throat diameter of 1 mm. These are first-stage nozzles. On the largest size of pump, and in the second stage the number of nozzles is 30, and these have a throat diameter of 5.2 mm., when using operating steam at 90 lbs. per square inch. Professor Leblanc, in his paper of 1911 to L'Association Technique Maritime, says that "the operating steam entrains the air by friction. During entrainment it is the velocity of the steam which is utilized. and not its kinetic energy." Calling M the weight of operating steam used per second, V its velocity at the outlet of the nozzles, m the weight of air drawn in per second, and W the velocity of the mixture of air and steam, then—$MV = (M + m)\ W$.

The ratio of kinetic energy, $\frac{mW^2}{2}$ of the air drawn into the kinetic energy, $\frac{MV^2}{2}$ contained in the operating steam as it comes out of the nozzles, can, therefore, be stated as

$$\frac{m\,W^2}{M\,V^2} = \frac{m\,M}{(M+m)^2}$$

so that when $\frac{m}{M} = 1, \frac{1}{2}, 1\text{-}3, \frac{1}{4}, 1\text{-}5.$

$$\frac{m\,M}{(M+m)^2} = .25, .222, .187, .160, .139.$$

This shows that if the utilization of the kinetic energy is to be the basis of the design, then for maximum efficiency it is necessary to bring the ratio

$$\frac{\text{Air dealt with}}{\text{Operating steam used}}$$

as near to unity as possible.

M. Leblanc continues:—"We tried to diminish the loss of kinetic energy by producing at the entrance of the diffuser a higher vacuum than was necessary, so that the fluid drawn in came in contact with the operating steam with a considerable velocity. If the efficiency of the diffuser could be brought almost to unity, we could add considerably to the over-all efficiency, but this has been found to be impracticable. Following on this, it was suggested to use puffs of steam after the manner of steam coming out of locomotive chimneys, but the complications involved in making arrangements for stopping the inlet of air during each puff were such that it would have been easier to use a centrifugal compressor. Afterwards we tried to compensate for the bad efficiency due to frictional entrainment by transforming heat into kinetic energy in the nozzles. Superheating the operating steam, although so useful for turbine work, is, however, not good for an ejector, because it is more difficult to effect compression in the diffuser which outweighs the advantages obtained in the nozzles. The next scheme was to use hot water in the nozzles, but this likewise proved unsuccessful."

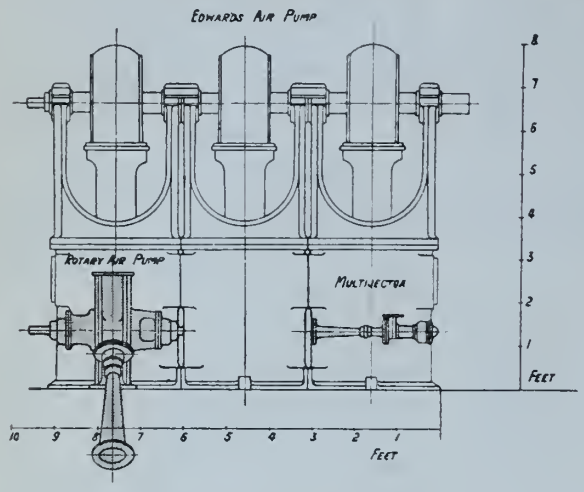


FIG. 12. RELATIVE SIZES OF "EDWARDS," ROTARY, AND MULTIJECTOR AIR PUMPS FOR SAME STEAM DUTY. WEIGHTS 20,832 LBS., 4,480 LBS., 97 LBS. RESPECTIVELY

Entrainment by Friction

After numerous other trials, it was decided that entrainment by friction was most economical, and various types of diffusers and different groupings of nozzles were experimented with, until the present ejector, as shown in Figs. 8, 9 and 10, was decided to be the most suited for condenser work. To go through the various stages in detail which led up to this design would take up too much time. With the form of ejector adopted, it has been found that the efficiency of the nozzle is on an average 85 per cent., whilst that of the diffuser is 70 per cent. It will be seen that this ejector agrees very well with the ideal ejector which Prof. Leblanc had in his mind. The first stage, which consists of a small group of nozzles, serves a triple purpose, inasmuch as it effects a certain amount of compression, heats up the entrained air, and gives it considerable velocity, and consequently an increase in momentum. The second stage has a larger number of nozzles, and it is here where the major portion of the work is done, the air being compressed from approximately 26 inches vacuum up to something more than atmospheric pressure. To be more accurate, the steam used in the first stage is about 5 per cent. of the total.

High Vacuum Results

In support of the fourth advantage which this air-pump is supposed to possess, the following figures were obtained on the French torpedo-destroyer Boutefeu. The turbines were stopped, but steam was on the glands. The volume to be evacuated was about 635 cubic feet. After one minute, the vacuum was 6 5-16 inches, two minutes 15 inches, three minutes 22 13-16 inches, four minutes 25 9-16 inches, five minutes 26¾ inches, and six minutes 27 9-16 inches. The theoretical vacuum corresponding to the temperature of the water 67.1 deg. Fah., viz., 28¼ inches, was attained in 11 minutes. It was also arranged later to allow certain known air leakages to enter the condenser. With a 5 mm. nozzle which passes 36.2 lbs. of free air per hour, the vacuum dropped only ⅜ inch. With a 15 mm. nozzle, which is equivalent to 326 lbs. of air per hour, the vacuum was 21¼ inches. With an inch cock full open it took 11 minutes for the vacuum to fall to 12¼ inches, at which figure the mercury column remained steady. On closing the regulating valve below the nozzle, the vacuum at once rose and attained the maximum almost immediately.

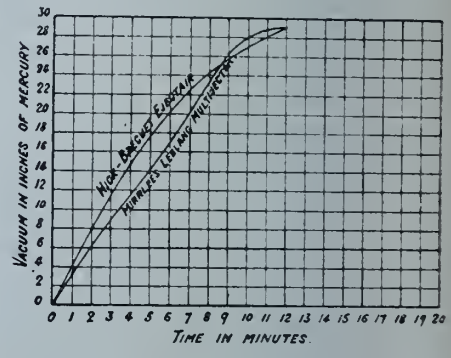


FIG. 14. DIAGRAM OF TIME TAKEN TO START UP A "HICK-BREGUET" EJECTAIR, AND A "MIRRLEES-LEBLANC" MULTIJECTOR.

There is a central station near Glasgow where this type of apparatus is at work with a multi-jet condenser. Sometimes when changing machines they are liable to partially lose their water for a minute or so, but none of the staff ever have to trouble about the ejectors for, as soon as the water comes back again, the vacuum at once builds up, and the set is never shut down through failure of the air-pumps. As a matter of fact, in the case above stated, it is highly probable that during the period that the water supply to the condenser is very small, there is an air passage between the water spaces of the other condensers in the station and the multi-jet plant which would allow of a very excessive quantity of air getting into the condenser on load. This also shows that stability, the sixth claim, is another salient point.

That high vacuum can be obtained is proved by the fact that this apparatus is now being used in the French navy and mercantile marine, as well as on some land installations for refrigerating pur-

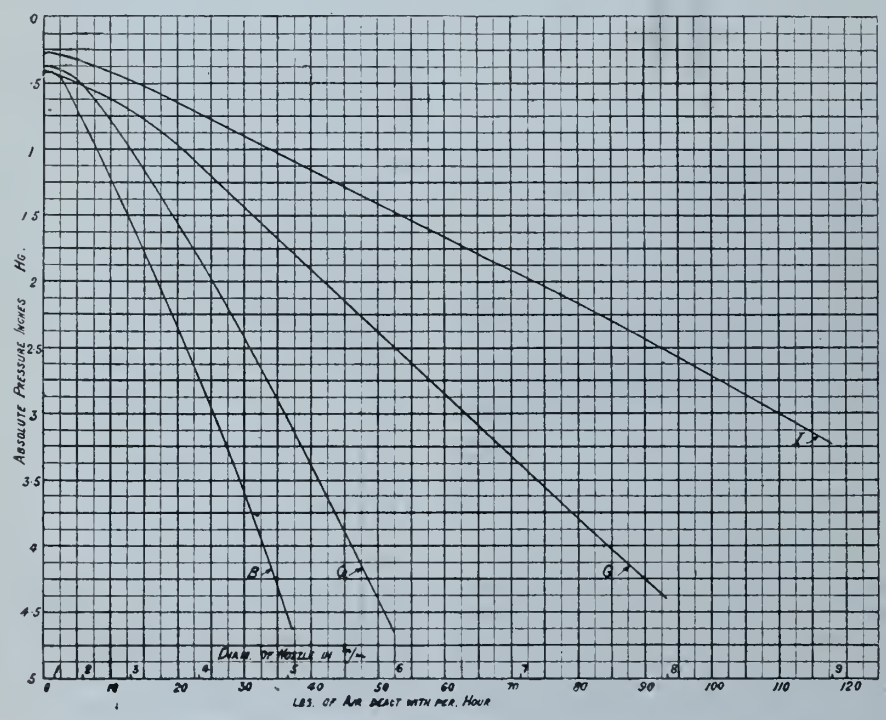


FIG. 13. AIR DEALING CAPACITY OF VARIOUS "MIRRLEES-LEBLANC" MULTIJECTORS.

poses, and installations are at work where the maximum vacuum obtained is within 1 mm. of the barometer. For condenser work the best results obtained so far by the French Westinghouse Co. are within 5 mm. of the barometer. From the foregoing remarks it would appear that this type of air-pump is ideal for use on board ship, and particularly in the navy, where space is so valuable and weight of such consideration. To illustrate this point, Fig. 12 has been produced, and represents to the same scale an Edwards' air pump, Leblanc rotary air pump, and Leblanc multijector for a steam duty on a surface condenser of 40,000 lbs. per hour, with water at 60 degs. The vacuum 28½ inches, and barometer 30 inches. The weights are approximately 20,832 lbs., 4,480 lbs., and 97 lbs. respectively. For land work it is equally suitable, and will soon supersede the rotary pump in many power stations. For sugar refineries, chemical, and other allied works it should prove exceptionally attractive, and take the place of many reciprocating dry air-pumps, particularly as in such factories the exhaust steam can generally be utilized to the fullest advantage on other processes. It may be advisable to point out here that this pump is purely a dry air-pump, so that for surface condensers as additional water or condensate extraction pump is still required, and for jet plants, the usual extraction pump.

No. 18 M. J. Condensing Plant with motor-driven Water-Extracting Pump, 1-Size "G" and 1-Size "I" Multijector Air-Pump installed at the Scottish Central Electric Power Co., Ltd., Bonnybridge.

Duty—50,000 lbs. steam per hour.
Vacuum—28·5" (Bar. 30")
Injection Water—3,800 Galls. per min., Temp. 65° Fah.
Air-Pump Capacity—84 lbs. air per hour with guaranteed vacuum and water temperature.
Large Ejector to operate condenser alone on loads over ⅓ and up to ⅔ full load.
Small Ejector to work alone on loads of ⅓ full load and under.
Both Ejectors to work on loads over ⅔ full load.

Time.	Load				Vacuum.		Barometer	Steam Press. on Ejectors.		Steam Press on Turbine.	Injection Water.		Extraction Pump.			
	Volts.	Amps.	P F	K W	Turbo.	Condr		"G"	"I."		Inlet.	Outlet.	Press Gauge.	Amps.	Volts.	R P M.
8.45 P.M.	6350	130	·75	1070	28·1	28·2	29·8	120	Shut off	152	–	—	5	58/60	440	480
11 0 A.M.	6350	266	·7	2000	28·5	28·5	29·66	122	130	152	43	70	4	60	..	..
12 0 A.M.	6370	280	·7	2152	28·6	28·5	29·63	122	125	152	43	70	4½	59	..	..
12 5 A.M.	6400	270	·7	2090	-	28·2	29·63	Shut	125	152	43	70	4½	59	..	..
2.15 P.M.	6400	325	·75	2700	28·2	28·25	29·59	125	160	150	43	72·5	5	62½	..	..
2 45 P.M.	6450	345	·76	2970	28·2	28·3	29·59	125	157	157	43	72·5	5	62½	..	..
3.0 P.M	6500	280	·74	2330	28·2	28·4	29·6	122½	160	153	43	65·5	4	62½	..	..
3.30 P.M.	6500	230	·7	1812	28·5	28·5	29·6	120	150	154	43	65·5	2	53	..	..

OFFICIAL TEST DATA OF "MIRRLEES-LEBLANC" MULTIJECTOR AIR PUMP.

Fig. 13 shows the aid-dealing capacity of various sizes of multijector pumps taken from the actual tests. The maximum vacuum in each case is equivalent to the theoretical, the slight difference at the origin of the curves being due to the different conditions under which each pump was tested.

The Table of Tests is taken from a plant installed at the Scotish Central Power Station at Bonnybridge at a date six months after the plant was put on commercial load. This Company have just decided to order another plant, and have specified Mirrlees-Leblanc multijector air-pumps.

Fig. 14 shows the time taken to start up a Hick-Brequet ejector and that of a Mirrlees-Leblanc multijector.

Figs. 15 and 16 show an application of Leblanc ejectors for refrigerating purposes. The arrangement is that supplied for magazine cooling on the French cruiser "Souffren."

There is no doubt that considerable improvements have been effected in air-pump design during the last few years, nevertheless there is still room for much further progress, and it is to be hoped that when hostilities cease and the British engineer has time once again for research work of this nature we shall have to drop all our present-day notions of efficient air-pumps for a type which will compel all others to become obsolete.

POWER PLANT OPERATION AND MANAGEMENT

TO obtain the greatest efficiency possible in a power plant is not only a matter of design, but a good deal a matter of proper operation and management. Most power plants could make large savings in this way, and there are exceptionally few where some improvements could not be made without spending a dollar for new equipment. To obtain full benefit from the equipment on hand, the men operating it must be made more efficient, and this can be done by education, strict supervision, pay according to merits (bonus system), competition and advancement, welfare.

Education, while the most important, is also the most neglected factor in economic operation of a power plant. This is especially true in the boiler room where the waste is greatest. Skilled labor should be employed. Ordinarily, anyone is hired who will work for low wages and maintain the steam pressure. Every boiler room should have a man with authority to give orders and with sufficient personality to have his orders respected. This man should predetermine by the proper use of various instruments, the most economical ways of burning coal and instruct the firemen as to the best methods, and then insist that these methods be carried out.

FIG. 15. APPLICATION OF "LEBLANC" EJECTORS FOR REFIGERATING PURPOSES.

FIG. 16. APPLICATION OF "LEBLANC" EJECTORS FOR REFRIGERATNG PURPOSES.

Jointly with extending the license laws and making examinations more strict, opportunity should be offered to men intending to become operating engineers to acquire the necessary knowledge. While the practical part can be learned in the power plant directly, the fundamentals of theory which are all important to the up-to-date operating engineer are difficult to obtain properly. Co-operation of educational institutions is needed by the forming of classes at the various universities and other schools to give courses on economic operation of power plants. Instruction should be given by correspondence to those unable to attend in person.

VOLCANIC STEAM POWER

By D. Street.

THE harnessing of volcanic heat to industrial purposes is an idea that has often presented itself to the visionary mind, but it needed the war to bring the project into the realm of commercial actuality. The price of coal in the inland towns of Italy has now reached the fantastic level of $50 a ton, and, in consequence, attention has been turned towards other possible sources of power.

In Central Tuscany, as is well known, there are numerous cracks in the ground from which jets of steam spout high in the air with great force and constancy. As far back as 1903, tentative experiments were made with a view to using this steam for the generation of power. Holes were bored in the ground down to the source of the steam, which is a hard stratum of rock about 300 to 500 feet below the surface. These bore-holes which are lined with iron pipes and vary from 15 to 20 inches in diameter, were found to yield steam with a pressure of 2 to 3 and exceptionally up to 5 atmospheres, at temperatures varying from 150 to 190 deg. C. For several years these jets have not been diminished in their capacity nor does a new boring seem to interfere with the preceding ones, provided the distance from one to another is not less than 50 feet.

Method of Application

In a recent communication, Prof. Luiggi has given an account of steps that are being taken to use this steam on a large scale. Prince Ginori-Conti, to whom the earlier experiments were due, acting on the advice of the Tosi Works, of Legano—specialists in steam turbines and alternating electric generators—ordered three groups of condensing turbo-electric engines, each of 3,000 k.w., working with superheated steam at 1½ atmospheres, to be worked by the head of the volcanic steam jets. The steam is not used direct in the turbines, on account of the corrosive elements, which it contains, but fed to specially constructed multi-tubular boilers which, in turn, give off the steam used in the turbines. In the boiler the volcanic steam gives up about 60 deg. C. of its heat, the temperature falling from 180 to 120 deg. C. The steam generated in the boilers and used for the turbines is thus ordinary water steam, which, on its way to the turbine passes along aluminum pipes heated outside by a current of superheated natural steam, at 180 deg. C.

After passing through the turbine that steam is discharged into a surface condenser, the circulating water of which is in its turn cooled in an ordinary cooling tower. The condensed steam from the turbines is, of course, pumped back into the boilers and thus no natural steam ever comes in contact with the turbines; by this arrangement corrosion is completely avoided. Professor Luiggi states that one of the 3,000 k.w. units has been at work since January, 1916, the second since April, and the third has just been started.

So far, the first two groups have worked quite successfully, and have been a great boon to the industries of Tuscany, greatly crippled by the scarcity and high price of coal. The very successful harnessing of volcanic heat to an electric power house can be increased practically to hundreds of thousands of horse-power, as the region of the steam-jet extends for many square miles.

REFRIGERATING PLANTS FOR NEWFOUNDLAND

ARRANGEMENTS have been completed by a fish corporation for the erection of a number of cold-storage plants at various places on the coast of Newfoundland. The principal plant will be erected in the city of St. Johns and will occupy ground space of about 245 by 90 feet. The plan calls for a six-story building, but only three stories will be erected at present. The basement will be of concrete, and above this the walls will be constructed of local brick. The lower flat will countain the freezing apparatus, having a refrigerating capacity of 150 tons, where fresh fish will be frozen in about two-hours. The ammonia plant for making artificial ice for preserving bait and for use on cars and steamers will be on the same floor. The second and third stories will be used for storage purposes. The entire building will have a capacity of about 10,000,000 pounds of frozen fish and will be equipped with two large elevators capable of carrying 5,000 pounds each.

Ten plants of much smaller capacity will be erected at other points, the largest of which located at Port aux Basques, will be capable of handling 1,250,000 pounds of fish. The others will have an average capacity of about 500,000 pounds. It is stated that the products of these smaller plants will be shipped over the railway to the plant at St. Johns, whence they will be forwarded to the English market. It is understood that contracts have been made with British firms to take all the frozen codfish that can be supplied for the next four years. The corporation is capitalized at $2,000,000 and expects to have its establishment working at full capacity within three years.

SMOKE PREVENTION

THERE has been considerable agitation great boom to the industries of Tuscany, portant cities smoke-prevention departments have been formed and laws made against smoke emission. The objections to smoke, as stated, are "public nuisance" and "fuel loss." The methods employed by smoke departments are effective in preventing the first, but the value of some of them as to the second is very doubtful. It is well known that the chief loss in a boiler plant is due to excess air (low CO_2), and not due to incomplete combustion, of which the result might be smoke.

To prevent smoke effectively, it is necessary to centre attention on the quantity of air used to burn the coal and keeping it down to a minimum, proper furnace temperature and possibilities for well mixing the combustible gases and the air. At present (with exceptions), most attention is paid to smoke and smoke alone, without paying the attention to excess air loss that it deserves. As a result many plants are wasting more fuel since operating smokelessly than before, because of using more excess air.

Smoke-prevention departments could greatly aid in preventing national fuel waste and some of them are doing so, but where they are not it can be laid to:—

(a) Political influence and interference.

(b) Lack of funds to employ expert inspectors.

(c) Employment of methods having no scientific basis and lack of effort to educate the engineer and firemen, while at the same time more force is employed than is good for the cause.

(d) Lack of confidence on the part of the power plant owner because of all of the above.

Exceedingly few firemen, not even 3 per cent., know the simplest rudiments of combustion. Many who are considered good firemen persist in operating their furnaces so that at least 20 per cent. of the fuel is wasted; at the same time claiming that it is the better and proper way. To overcome such conditions they must be educated.

It would be a great help if more of the simplest literature could be obtained, describing the economical process of firing, and this written in an interesting way. It is not meant that there is no such literature, for an immense amount of good has been done by different journals of this character, but the man who needs it most does not get it, and it would pay to bring it to him.

The U. S. Bureau of Mines would increase its usefulness by including in its excellent editions on fuel technology from time to time, bulletins of a thoroughly practical nature especially adapted to the average boiler-room man. These bulletins should be written by men who know the fireman and who have been through the mill themselves. After such bulletins are ready they should not be kept until those who need them write for them, but they should be given a forced circulation with the aid of boiler-insurance companies, smoke-inspection departments, business men's leagues, etc.

Power Transmission Section

LEATHER BELTING

A PECULIAR condition exists in the machine and railroad shops of the country in the purchase and use of their leather belting, and it may fairly be assumed that the majority of them are buying and using leather belting of a very inferior character, says L. W. Arny in the *Iron Age*. In some cases this is due to a deliberate selection of cheaper grades, but in most of them it is due to the ignorance of the purchasing authorities, the attraction of lower prices, and the delusion that quality can be secured without paying an adequate price for it. One of our important railroads has said in substance that they find certain second and third qualities quite sufficient for their requirements.

The practice in leather belting in most of these shops is based, at least in part, on the study on this subject originally formulated by Frederick W. Taylor, and by his coadjutor and successor, Carl G. Barth, and these men after considerable belting experimentation determined upon a tension equivalent to about 70 lb. per sq. in. as that giving most satisfactory results. It was understood that this tension was much below the actual capacity of the belts, but the purpose was to adopt a tension that would be such as to reduce to a minimum the labor and attention of maintaining it, and of securing a long life for the belt, and it was intended that by the use of leather belts of high grades, the utmost economy would be attained; this was doubtless the result, and Mr. Barth to-day after a good many years of experience with this tension, is still insistent that good qualities of belting only be used.

Working Tension Too Low to Measure Quality

But the use of this low tension, though conducing to the economy of operation and the long life of the belt, is so low as to make possible, with temporarily successful results, the use of much inferior qualities of leather belting, and these lower grades, introduced into the shops either intentionally, as with the railroad mentioned, or ignorantly through a bad purchase, have been sufficient to keep the pulleys in a state of revolution for a time, and their subsequent performance has been over-looked or forgotten. This is more particularly true where there exists so large a gap between the purchasing and operating departments as is usual with the railroads. Unless the leather belts supplied fail to do their work, the operating department is not inclined to make trouble with the purchasing department, shutting their eyes to length of life.

The idea that the cheaper grades of leather belting can produce the same economical results as the better qualities is just as fallacious as the same thought in application to other materials. A good leather belt is capable of such a long life under reasonable conditions, and real economy is so dependent upon length of life, that the use of inferior qualities made from belly and shoulder portions of the hide is pure extravagance, and yet many of our best shops are filled with the worst junk that the leather beltmaker can put together.

No Accepted Test For Belting

Leather belting does not lend itself to the mental processes of the average purchasing agent. It is a specialty which is poorly understood even by those most practical in its use. It is not standardized as are some other products. It cannot be bought as a standardized article on price only, and when the purchasing agent places his order or his contract with the lowest bidder, he gets only and not a particle more quality than he pays for. The lowest bidder is always the one least qualified to supply the goods desired. The fact that the receivers and the operating department are not qualified to determine the quality of the goods delivered from their appearance or from any tests which they are capable of applying is an open invitation or possibly a defiance to the lowest bidder to come in and defraud them. There will come a time when this condition will be changed, for the leather belting manufacturers through the Leather Belting Exchange, in connection with the Mellon Institute of Industrial Research, is at work in an effort to produce specifications that will really specify, and the results of which may be identified on delivery. At this time this is impossible, and the present variety of specifications for leather belting is ridiculous because no man can tell on delivery whether the goods comply with them or not.

There is a large opportunity for the machine and railroad shops of the country to make material savings in their belting expense by the use of better qualities. It is possible for them to secure a better efficiency from those belts in operation; to reduce the costs of care and maintenance, and to reduce the costs of replacement. Leather is a practically indestructible material. It does not corrode, oxidize, ferment or crystallize and time produces no effect upon it. There are records of belts which have carried their loads for 30, 40 and even 50 years and are still running, after having traveled millions of miles, and this wonderful efficiency should be secured for the machine and railroad shops. But it must be understood that the maximum efficiency and length of life can be secured only from use of the first quality, and not from the second and third quality belts bought because their first cost is smaller.

There need be little trouble about securing a good quality of leather belting for use in these shops if the purchasing departments will go about it properly. As previously explained, it cannot be bought on specification or price, but there are many reputable manufacturers whose brands and trademarks can be depended upon and a reliance upon recognized brands, and the payment of a sufficient amount of money, will secure the desired qualities. Mr. Arny is secretary of the Leather Belting Exchange, Philadelphia, Pa.

POSITIVE AND FRICTION CLUTCHES

By T. J.

THE attempt to find a satisfactory form of clutch has yielded many excellent types and designs, but no clutch yet invented has shown such all-round superiority as to supersede all other designs. The claw coupling is the simplest and most effective of all clutches when once it is in action, for it consumes practically no power, and shows no wear, but it cannot be put in and out of a gear except at slow speeds, or when the machine is stopped. For a drive that can be connected or disconnected at full speed and under full load, some form of friction clutch is necessary. The cone clutch is the simplest of all friction clutches, and although innumerable other types of friction clutch have been introduced—segment clutches, band clutches, disc clutches, magnetic clutches, centrifugal clutches, etc.,—it still remains a prime favourite. The conditions to be fulfilled by the ideal clutch are many and diverse. It must be simple in construction, and free from undue wear; it must engage smoothly, and when engaged must grip firmly, yet there must be no "bite" that will prevent easy disengagement; the grip must not be incurred at the cost of heavy pressure on the moving part, as there will be a wear

and loss of power; the amount of movement required to put the clutch into action must not be too great, and yet the clearance when out of action must be such as to ensure that there is no rubbing. These are but a few of the conditions to be observed.

Theoretically the ideal clutch, as suggested by Mr. W. G. Gass, would be a combination of friction and positive clutch. It would employ a friction arrangement for starting up, and when that had done its part a positive drive would come into operation, and take all the work of driving off the friction surfaces. The designing of a combination clutch of this kind is not an easy matter. The difficulty would come in providing for its being thrown out of gear with the same ease as a friction clutch, for when the positive part of the clutch comes into action it is this part which will be doing the work, and will be under pressure, and to withdraw this part from engagement will present the same difficulty as is found with a claw coupling.

BALL BEARINGS IN THE WOODWORKING INDUSTRY

TEN years ago ball bearing woodworking machines were a luxury. Very few were in use, because they were not needed, but labor cost began to climb and with it the construction of woodworking machinery underwent a complete change. Manufacturers demanded more work; production had to be increased to offset high expenses. This meant that each machine had to work at higher speed, and with heavier cuts. Immediately there was trouble. Bronze bearings which had been satisfactory, showed unexpected weaknesses. Hot boxes, burn-outs, and rapid wear were the rule. Evidently it was necessary to find some type of bearing which would stand up under heavy duty. After considerable experimenting some manufacturers turned to ball bearings, and their doing so marked the advent of ball bearings in woodworking machinery. From the very start they proved their ability to stand up to the most exacting requirements. Aside from this, however, ball bearings brought a host of advantages, among which were better work, more work, less power, less oil, cleanliness, freedom from hot boxes, reduced fire risks and lasting accuracy.

The advantages of ball bearings for woodworking machinery are: increased production; improved quality; accuracy of bearing detail; reduced maintenance; reduced number of accidents; bearing troubles minimized. A brief consideration of these points will prove each advantage clearly.

Reliability at High Speeds

It is plain that ball bearings would not be used if they were unreliable at high speeds, because makers and users demand speed. Ball bearings were tried when bronze bearings failed. After ten years of real service they are in use in most types of woodworking machinery, and this is the proof of their reliability at high speeds.

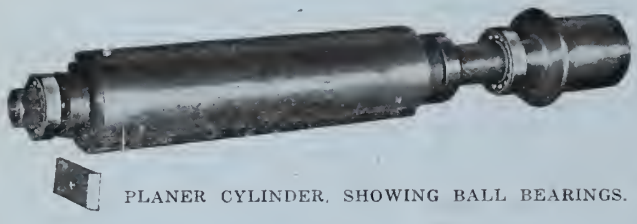
Increased Production

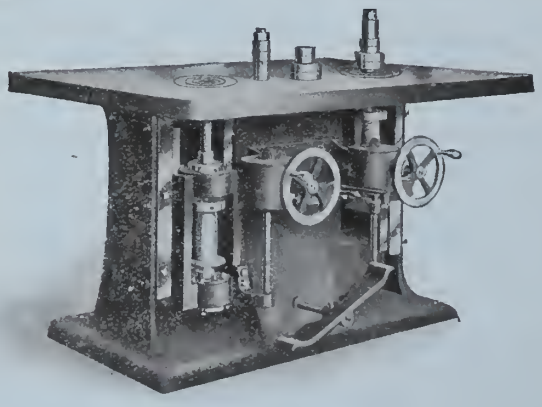
A knife rotating 8,000 r. p. m. makes many more cuts a minute than a knife rotating 5,000 r. p. m. This is one reason why ball bearings increase production—they allow higher speeds and more cuts per minute. It has also been found by practical experience that ball bearings give a great reserve power to the machine by reducing the power wasted in friction, therefore, machines equipped with ball bearings can take heavier cuts. This is particularly noticeable in such machines as planers and shapers. A ball bearing shaper will easily take cuts that are heavy enough to stall a bronze bearing shaper

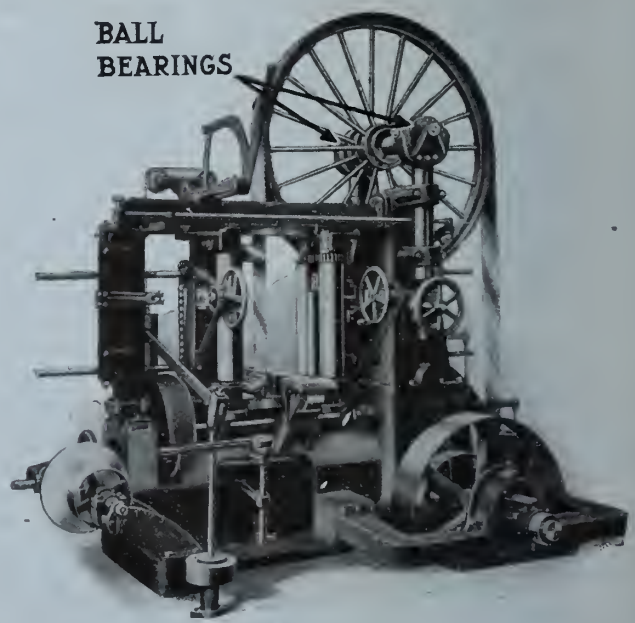
Improved Quality of Work

Users soon found that the quality of work done on ball bearing equipped machines was better and more uniform than that done on plain bearing machines. There are reasons for this. First, ball bearings are extremely accurate; a wheel, a cutter cylinder, or an arbor mounted in ball bearings can be adjusted with a high degree of accuracy. Second, ball bearings are self-aligning; any bending of the shaft is taken up by them. The bearing itself is so constructed that, without any special housing, it will compensate for shafting that is out of line. It is also practically impossible to bind a ball bearing; the shaft runs freely in any position. It is well to remember this, because no matter how much care is taken, sudden loads and uneven pulls will cause bending and deflection of shafts. High speed also improves quality because high speed means more cuts per minute, resulting in cleaner cut work.

BUZZ PLANER, BALL BEARINGS ON CUTTER CYLINDER.


PLANER CYLINDER, SHOWING BALL BEARINGS.


SHAPER, BALL BEARINGS ON SPINDLES.



BAND RESAW, BALL BEARINGS CARRYING UPPER WHEEL.

Bearing Detail Accuracy

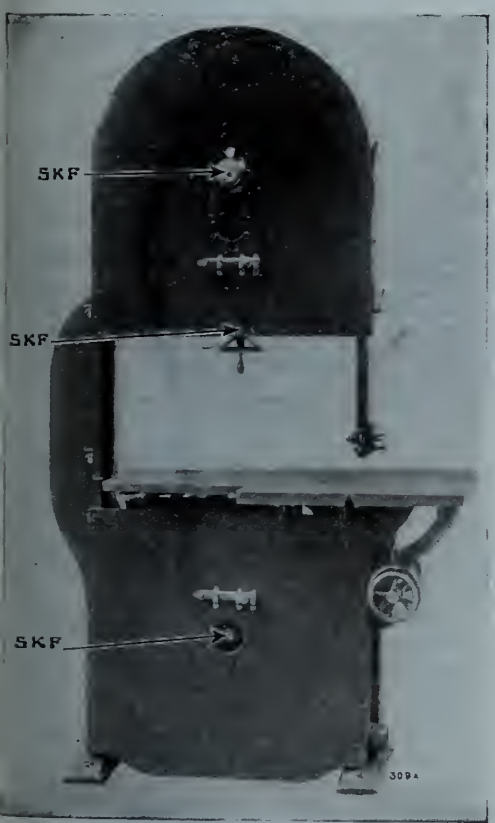
Ball bearings are made of high-grade materials, heat-treated in the most modern way and ground accurately to the ten thousandth part of an inch. The accuracy is lasting. Hardened steel balls rolling on hardened steel races practical-

BALL BEARING BARKER.

ly eliminate all wear. Ball bearings put in woodworking machinery in 1907 are running today and are still giving the same care-free, reliable service, as when new.

Reduced Maintenance

Due to their low friction, ball bearings are very economical to use. The power saved can be turned to other work and the saving made will show up in actual



BALL BEARING BAND SAW.

money. Ball bearings save oil. They use very little, only a small fraction of the oil used by plain bearings, the bearing being so housed that it will hold enough oil to last for months. Furthermore, the housing is oil-tight, so no lubricant can be lost by leakage. An oil tight housing also means a clean machine, a clean plant, protection from fire risk due to oil soaked waste and "live" belts unspoiled by oil.

Belts on ball bearing equipped machines last much longer, because they do not run high tension, and are free from oil. Also, the machines start easily, the bearings do not stick, and there is no excessive tension when starting. All of the above help materially to lengthen the life of belts. If motors are equipped with ball bearings, another big saving is effected. The motors use little lubricant and are largely free from many troubles that often tie up production. Ball bearings are practically wearproof, so there is no need of replacing worn bushings. The danger of worn bearings allowing the armature to touch the pole pieces is in consequence entirely avoided.

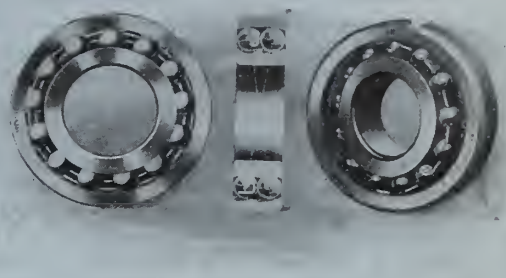
Reduced Number of Accidents

Poorly adjusted bearings, play, hot boxes, pools of oil—all are frequent causes of accidents or fire, and all are eliminated by ball bearing installation. The parts are carried in correct adjustment and the bearings themselves are non-adjustable; no adjustment is necessary. Play is the result of wear. Hot boxes may be said to be unknown where ball bearings are used. The bearing is constantly bathed by oil, and since there is no friction there is also no heat. Fires from this source are therefore effectually prevented. Another source of fire is oil-soaked waste. Sawdust or shavings soaked with oil have been the start of many fires. By using ball bearings, housed perfectly oil-tight, this danger is removed. Pools of oil that collect dirt and leave slippery spots are a constant source of danger.

Some of the advantages mentioned here are more important than others, also some of them are more marked in one type of machine than another; but no matter what the machine is, the service and advantages gained by equipping it with ball bearings are certain and great. A prominent manufacturer of woodworking machinery who is a large user of ball bearings has expressed his opinion very clearly in one of his folders, thus:—"Steel ball bearings have so many advantages over both bronze and babbitt bearings then the manufacturer who once uses them will be satisfied with nothing else, provided of course that the ball bearings in the particular machine he is using are of the highest grade and of the best type procurable." We are indebted to the SKF Ball Bearing Co. for the illustrations accompanying this article.

COKE FUEL FOR POWER STATIONS

THE Highways Committee of the London County Council has placed an order for eight coke-burning mechanical stokers for use under steam boilers at the Greenwich generating station. The use of mechanical stokers for firing boilers with coke fuel has passed the experimental stage in more than one power station, but the London County Council will no doubt regard the present installation as more or less experimental so far as they are concerned. It is calculated that the



RADIAL BEARING SHOWN IN NORMAL. SECTIONAL. AND IN DEFLECTED POSITION.

first set of stokers now contemplated will, if worked to their full capacity, consume 100 tons of coke per 24 hours; and having regard to the relatively high cost of coal, as well as the relatively greater degree of efficiency attained in burning coke, every effort will no doubt be made to use the new stokers to their full capacity. The present total coal consumption at the power station has been estimated at 165,000 tons per annum, and according to a figure recently published, the present price is approximately $8 per ton. Having in mind the huge surplus of coke available in London before the war, the financial advantages to the Council will be considerable.

From a national point of view, the advantages accruing from the policy of using coke in lieu of raw coal to the extent indicated are no less important and far-reaching in their incidence, in view of the abnormal and increasing cost of imported raw materials used in the manufacture of carburetted water gas, a commodity which however desirable and useful in normal times is now regarded as expensive from more than one point of view. Based upon the total yearly consumption which is by no means the largest of any individual power station in London, the valuable residuals which

MOUNTING OF A SHAFT IN BALL BEARINGS.

would be recovered by diverting this quantity of coal through the gas works would include 1,650 tons of sulphate of ammonia, 300 tons of high explosive material, and 1,650,000 gallons of coal tar.

High Pressure Air Compressor Design and Application*

By Joseph M. Ford

Compressed air at high pressure is beco ming an increasingly important medium in modern engineering practice and in naval warfare. The accompanying paper deals with the machines which produce high pressure air, leaving on one side the question of power transmission by compressed air. In passing, the principal advantages of this system are referred to, and will be seen to be of considerable value. They consist of the facility with which energy can be stored; the unlimited rate at which accumulated energy may be converted into useful work; and, apart from loss of efficiency, leakage cannot cause any awkward consequences.

ONE of the best instances of the adoption of high-pressure air as a medium for power storage is to be found in torpedo work. The torpedo is launched from the tube by means of compressed air, usually stored at a high pressure, and when in the water is propelled by an engine de-

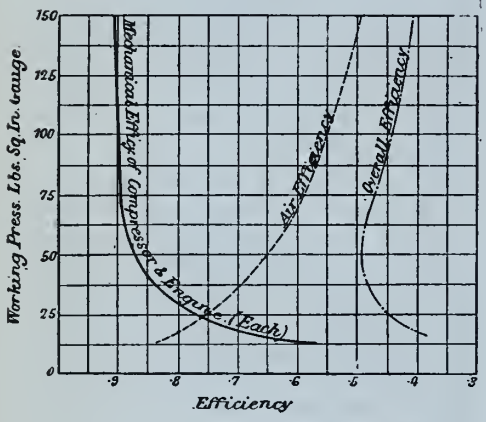


FIG. 1. SINGLE STAGE COMPRESSED AIR POWER TRANSMISSION. NO PREHEATING. MECHANICAL EFFICIENCY OF ENGINE ASSUMED TO BE SAME AS THAT OF COMPRESSOR. COMPRESSION IN LATTER AND EXPANSION IN ENGINE ASSUMED TO BE ADIABATIC.

riving most of its power from compressed air.

The starting of prime movers of the internal combustion type of considerable size is almost invariably carried out by compressed air, except perhaps in very special cases, such as some generating sets, where the dynamo can be "motored."

In marine work, with engines of the Diesel and other types, reversing and manoeuvring involve the displacement of a considerable amount of the valve-driving mechanism—most conveniently accomplished by compressed air.

One of the principal applications, however, is in the Diesel engine itself, where compressed air is used, not as a medium for energy storage in the usually accepted sense of the term, but to inject the liquid fuel into the working cylinders against the compression pressure of about 30 atmospheres (430 lbs. per sq. inch.)

In some oil-engined ships, high-pressure air is used for driving some auxiliaries, such as steering gear, main engine turning gear, small pumps, etc.. and in submarines the air is used, among other things, for blowing the ballast tanks.

*Part I. of a paper read before the Greenock (Scotland) Association of Shipbuilders and Engineers.

Pressures Adopted in Practice

Within limits, the lower the working pressure of the air, the higher the efficiency, but exigencies of space and weight may demand that the storage reservoirs shall occupy minimum space, in which case, for a given amount of energy stored, the pressure should be as high as possible—particularly, for instance, in a torpedo, where the dimensions and weight of power plant must be cut down to a minimum, almost irrespective of cost, and the pressures employed range accordingly from 2,000 to 4,000 lbs. per square inch.

With internal combustion engines, the design and type determine the pressure of the starting air. For example, gas, paraffin and petrol engines are frequently started with air at 100 to 300 lbs. per square inch. With Diesel engines of the four-cycle type about 300 lbs. per square inch usually suffices, whereas in engines of the two-stroke type the pressure may be as high as 1,000 lbs. per square inch. One of the disadvantages of using high pressures in this connection is that when starting a refractory engine—which does not readily pick up on fuel—the continued expansion of high pressure air in the working cylinders lowers the temperature to such an extent that the heat of compression is insufficient to ignite the injected oil. With reversing mechanism the obvious advantage accruing from the use of air at high pressures is that the dimensions of the servo-motors may be kept within small limits, which is of moment in some installations, although the higher the pressure the more difficult it is to maintain tightness and the better must be the fits, etc.

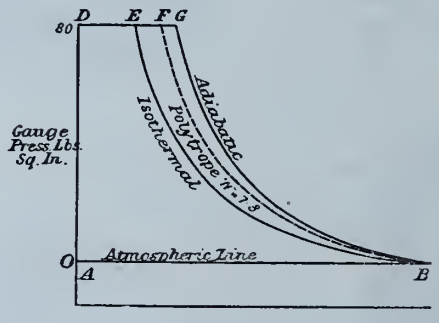


FIG. 2.

Initial temperature of air.. 60 deg. F.
Initial pressure ..... 14.7 lb. per sq. in. abs.
Final pressure ..... 94.7 " " "

WORK REQUIRED TO COMPRESS AND DELIVER 1 CUB. FT. OF FREE AIR.

(i) Isothermal compression ..... 3950 ft.-lb.
(ii) Polytropic compression ("N"=1.3) 4950 "
(iii) Adiabatic compression ..... 5275 "

In this case 30 per cent. more work is required for adiabatic compression than for isothermal compression. Hence note importance of cooling during compression.

TEMPERATURES ATTAINED AT END OF COMPRESSION.

(i) Isothermal compression ..... 60° F.
(ii) Polytropic compression ("N"=1.3).. 335° F.
(iii) Adiabatic compression ..... 435° F.

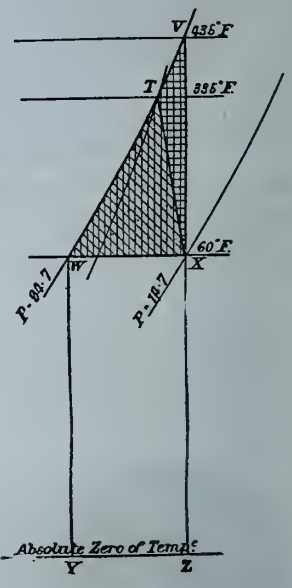


FIG. 3.

Temperature entropy diagram for compression of 1 lb. of air from 14.7 lb. to 94.7 lb. per sq. in. abs.
Heat equivalent of work required for isothermal compression = area WYXZ.
Heat equivalent of extra work required if compression is adiabatic = area VWX (vertical shading).
Heat equivalent of extra work required if compression is polytropic = area TWX (diagonal shading).
Heat equivalent of work saved by cooling shaded horizontally.

For fuel injection. the air pressure is determined by the theoretical cycle of operations in the working cylinder, and varies from 600 to 900, and in extreme cases even to 1,000 lbs. per square inch, according to the particular design of engine. kind of fuel and load.

The question of driving auxiliaries by compressed air is a vexed one. Unless the air can be heated before expansion in the engine cylinder, low initial pressures should be used. With high pressures the re-expansion lowers the air temperature so much. due to work being done by the air. that snow forms and interferes with the working of the valves.

throttle passages, etc. Fig. 1 shows the theoretical efficiency of a transmission system when there is no pre-heating. The mechanical efficiency of the engine at the different pressures is assumed to be the same as that of the compressor at the corresponding pressures. The "air efficiency" is the ratio of work obtained from the air in the engine to the work done on the air in the compressor. A considerable gain in efficiency may be effected if the air can be heated before use, especially when this can be inexpensively done—e.g., by the exhaust gases of an internal combustion engine. The advantages of this system are nullified, more or less according to particular circumstances, by the low efficiency. Practical considerations, such as the question of leaks, etc., favor low pressures, whereas such considerations as the size of pipes, cylinders and storage generally demand a compromise, although it is cheaper to make an efficient large low-pressure reservoir than a satisfactory small high-pressure one.

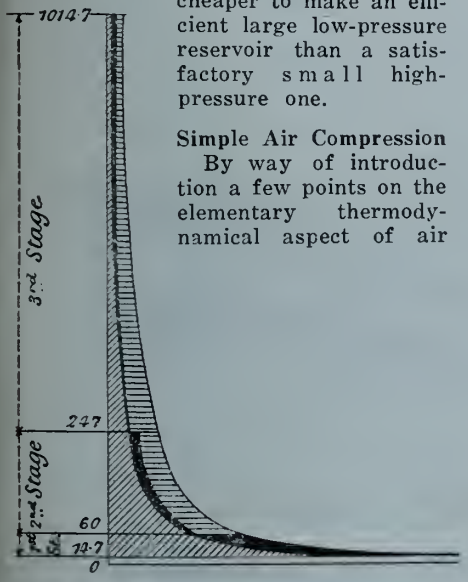


FIG. 4. Pv. DIAGRAM.

Simple Air Compression

By way of introduction a few points on the elementary thermodynamical aspect of air compression may assist towards the understanding of the special features of high-pressure compressors. If air be compressed isothermally, a certain amount of work has to be done—see Fig. 2, giving a theoretical indicator diagram for a machine delivering air at 80 lbs. per square inch. With isothermal compression the work required is represented by the area ABED. If the compression be adiabatic, then the additional work required is represented by the area BGE, from which it will be seen that the aim should be to secure isothermal compression, that is, to prevent increase of the temperature of the air during compression. Not only from the point of view of power absorbed should the temperature rise be small, but also for mechanical reasons, as later explained.

The index "n" in the standard equation $PV^n = C$ is in some ways a measure of the amount of heat abstracted during compression. With adiabatic compression its value for diatomic gases such as air is 1.41, and with isothermal compression its value is unity. In actual practice the amount of heat removed by a water-jacket on an air compressor cylinder is such that its value lies between about 1.28 and 1.35, the latter value being more applicable to large high-speed machines.

The line BF on Fig. 2 represents compression according to the law.

$$PV^{1.3} = \text{constant.}$$

This means that the saving in work effected by cooling the air during compression is represented by the area BGF. Moreover, the reduction in the final delivery temperature is to be noted.

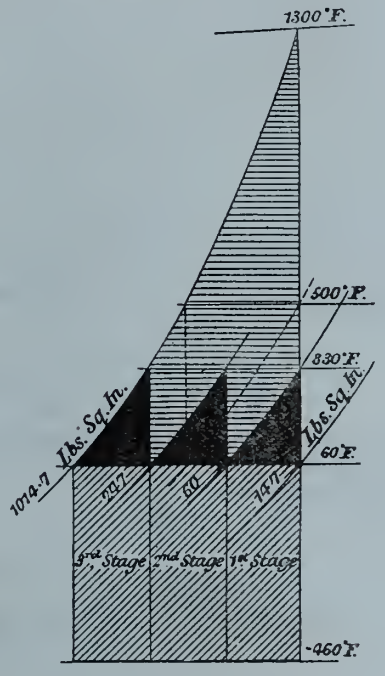


FIG. 5. Oo DIAGRAM.

THEORETICAL DIAGRAMS SHOWING SAVING EFFECTED BY STAGE COMPRESSION. COMPRESSION TO 1,000 LBS. PER SQUARE INCH GAUGE.

In an ideal compressor, i.e., one in which compression is isothermal, the work required per unit of air is represented by the diagonally shaded area of each diagram. If compression were carried out in one stage the work required is represented by the total area of the diagram. The horizontally shaded area represents the work saved by compressing in three stages and intercooling. The darkly shaded area represents the amount by which the work required for three-stage compression is still in excess of the ideal. Note the huge saving of three-stage over one-stage compression. In this case the saving is 29½ per cent.

The diagram in Fig. 3 is the "theta" "phi" diagram corresponding to Fig. 2. This shows rather more clearly the difference in the work required and temperature attained by compressing under the various conditions. The figure is self-explanatory.

Compression in Stages

When pressures of 1,000 lbs. per square inch and over are required, the temperatures attained by single-stage compression would be extremely high. If lubricating oil could be eliminated from the problem, careful design might succeed in producing a compressor that would stand the stresses set up by the high temperatures.

Lubricating oil burns in air at such temperatures, with the result that the pistons would become carbonized, the valves clogged and the pipes sooted-up. In addition, high temperatures have deleterious effects on tempered steel valves and springs. With large high-speed machines the temperature, coupled with the peculiar fatigue phenomenon, makes it well nigh impossible to get satisfactory working with temperatures higher than those consequent upon about six compressions in one stage.

If the excessive work of compression and high temperatures are to be avoided, the heat must be abstracted from the air in the period between the start of compression and the commencement of delivery. Jacketing alone is insufficient. The method that suggests itself is to compress the air a small amount, then withdraw it from the cylinder, cool it to atmospheric temperature, and return it to the cylinder. Next, move the piston further to compress the air still more, and repeat the cooling process, and so on, until the required pressure is attained. This is virtually the method adopted in practice, except that in lieu of carrying out the whole process in a single cylinder, one cylinder is devoted to each stage of compression, and between each stage the air is passed through an intercooler to reduce its temperature to the initial atmospheric temperature. The saving in work effected by stage compression with intercooling is shown in Figs. 4 and 5. The PV diagram, Fig. 4, has been drawn for a three-stage machine compressing to 1,000 lbs. per sq. inch.

If the heat of compression could be removed as fast as it is generated, as with isothermal compression, the work required to compress unit volume would be represented by the diagonally-shaded area. This is the ideal condition. If the compression were carried out in one stage and no heat were removed—that is, if the compression were adiabatic — then the work required to compress unit volume of air would be represented by the total area of the diagram, that is, the diagonally, plus the black, plus the horizontally shaded part. The ratio of this total work to that required in isothermal compression will be noted. If, again, the air were compressed adiabatically to 60 lbs. per square inch only and then cooled to its initial temperature, its condition will then be the same as it would have been had it been compressed isothermally. From this point the second stage of compression is carried out and the cooling process repeated, meaning that the area of the second stage diagram is only the diagonally shaded portion plus the black portion, the horizontally shaded part being completely saved, due to the reduction in the volume of air dealt with, as a result of the intercooling.

Similar conditions obtain in the third stage, the horizontally shaded part again representing work saved. The work required for adiabatic compression in three stages is thus represented by the diagonally shaded portion plus the black portion, which latter represents the amount by which the work required is still in excess of the ideal.

Fig. 5 is the "theta" "phi" diagram corresponding to the PV diagram in Fig. 4.

The corresponding areas are similarly shaded. In addition to the work required, this diagram shows the temperatures attained in compression under the various conditions. The reduction of the temperature due to staging is clearly shown. The 1,300 deg. F. is a theoretical value, 500 deg. F. is the temperature which would be attained were the compression carried out in two stages, and 330 deg. F. is the result of three-stage compression. In the case under consideration the total work is equally divided between the stages, whereas in actual practice this condition does not generally hold exactly.

The temperatures attained in the cylinder when air is compressed to various pressures in one, two or three stages, with intercooling, are given in Fig. 6. Piston friction and the effect of the cylinder walls have been neglected. As previously stated, the high temperatures could not be dealt with in practice. The temperatures given for two and three-stage compression are based on the assumption of perfect intercooling, which

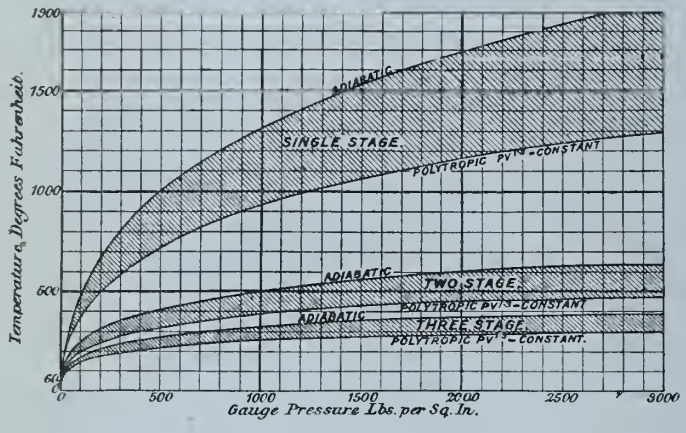


FIG. 6. TEMPERATURES ATTAINED WITH ONE, TWO AND THREE-STAGE COMPRESSION TO VARIOUS PRESSURES. INITIAL TEMPERATURE IN EACH STAGE OF COMPRESSION ASSUMED TO BE 60° FAH.

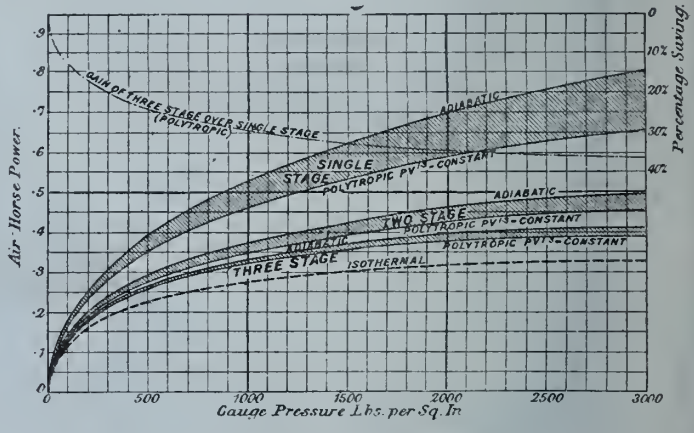


FIG. 7. AIR HORSE-POWER REQUIRED PER CUBIC FOOT FREE AIR PER MINUTE WITH ONE, TWO AND THREE-STAGE COMPRESSION TO VARIOUS PRESSURES.

condition holds for well-designed machines. In some plants where there is a copious supply of cold water, and where intercoolers of liberal dimensions are fitted, the air can be cooled between the stages to less indeed than the initial temperature.

Fig. 7 gives the air horse-power required to compress 1 cub. ft. of free air per minute in one, two and three stages to various pressures, and shows how the power required approaches the ideal (isothermal compression), and the ill-effects of inefficient jacketing diminish as the number of stages is increased. For example, with air compressed to 1,000 lb. per square inch in one stage, according to the law $PV^{1.3} = \text{constant}$, the power required would be 0.46 a.h.p. per cubic foot; but if the cooling were very inefficient, so that the compression were adiabatic, the power would rise to 0.53 a.h.p. per cubic foot—an increase of 15 per cent. With three-stage compression, according to the same law, the power required would be 0.32 a.h.p. per cubic foot, and in this latter case, assuming that the cooling were inefficient, the power would only rise at the most to 0.335 a.h.p. per cubic foot—an increase of 5 per cent., against the 15 per cent. obtained when compression is carried out in a single stage.

Apart from the questions of efficiency and temperatures, an advantage of staging is the reduction of crankpin loads and stresses generally—the reasoning being exactly the same in this connection as for a compound or triple-expansion steam engine. Theoretically an infinite number of stages is required, but practical considerations, such as the multiplicity of parts, the low mechanical efficiency, weight, cost, etc., limits the number of stages.

Pressures and Number of Stages

The best practice is as follows: The maximum terminal pressures are, for one stage, 80 to 100 lb. per square inch; two stages, 600 lb. per square inch; three stages, 1,500 lb. per square inch; four stages, 2,500 to 3,000 lb. per square inch; five stages, 4,500 lb. per square inch; and above 4,500 lb. per square inch, six or seven stages to 6,000 lb. per square inch, which is about the highest pressure for which an air compressor has been constructed.

In the case of very small machines these pressures, for a given number of stages are often exceeded in order to reduce complication. For example, machines have been constructed and work quite satisfactorily when compressing to 2,500 lb. per square inch in two stages. The temperatures attained, however, make it necessary to carry out the cylinder lubrication by soapy water.

Effects of Cylinder Clearance Volumes

An important consideration in the design of a multi-stage compressor is the computation of the clearance volumes of the various cylinders. By clearance volume is understood not merely the volume of the space which separates the piston from the end of the cylinder when the crank is on dead centre, but, in addition to this, the volume of all valve ports and pockets, space behind piston rings if these are air-packed, and, in short, any space into which the air can be compressed, without passing through the delivery valve. With an ordinary single-stage compressor, such as would be used to drive pneumatic tools in a shipyard, the designer aims to reduce the cylinder clearance to the minimum, for by so doing a greater quantity of air is delivered per stroke than would be the case with a larger clearance. Fig. 8, which is a theoretical card for a cylinder compressing to 80 lb. per square inch, is given in explanation. With zero cylinder clearance the volume of air delivered is represented by CD, whereas with 10 per cent. clearance and the same cylinder dimensions the volume delivered becomes FD. Less air is drawn into the cylinder per stroke, since the air left in the clearance space re-expands along DE, for a portion of the suction stroke, as shown, and the suction valves do not open to admit a fresh supply of air until the point E in the stroke is reached. In this way the volume of air aspired is only EB, as compared with AB—the volume dealt with in the same cylinder without clearance. The ratio $\frac{EB}{AB}$ is known as the Indicated Volumetric Efficiency, and in this particular case is about 69 per cent. The smaller the clearance space, the nearer will E be to A, i.e., $\frac{EB}{AB}$ will be greater, and a larger volume of air will consequently be dealt with per stroke.

With a large clearance a larger cylinder is required to deliver a given amount of air than with a small clearance, yet the indicated work done per unit volume of air dealt with remains the same, although the larger cylinder makes for a heavier and more costly machine, with greater piston loads, so that in general practice the clearances are made as small as possible. Referring again to Fig. 8, the higher the compression is carried, the further will E be removed from A, that is, the higher the delivery pressure at which a given cylinder is working, the less will be the indicated volumetric efficiency. Further, if the clearance air receives heat from the cylinder and piston whilst expanding, the law of expansion will approach the isothermal and the pressure of the clearance air will take the longer to drop to the suction pressure.

or E will be still further removed from A to G.

It is to be emphasized that the air should not receive heat whilst re-expanding, or, in other words, the clearance space should be as efficiently cooled as possible. The cooler the walls of the

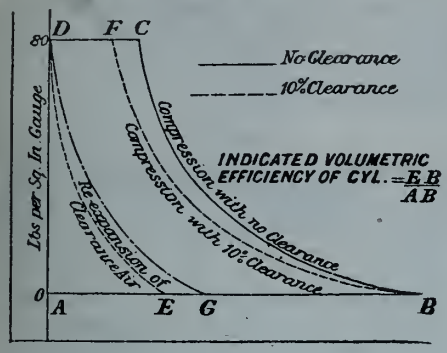


FIG. 8.

clearance space, the more rapidly will the pressure of the re-expanding air fall to the suction pressure and the greater

$$\frac{EB}{AB}$$

will the ratio become. Moreover, if the clearance air receives heat whilst re-expanding, its temperature at point E will be considerably higher than the temperature of the incoming air. As a result of the mixing of the new supply with the hot clearance air, the temperature at the end of the suction stroke, i.e., at B, will be higher than it would have been had there been no hot air left in the cylinder at point E, thus reducing the weight of air dealt with per stroke and increasing the temperature of compression. In any case the temperature of the air at B must be higher than that of the suction air, owing to contact with the hot walls and piston.

In modern practice, the cylinder clearance volume for a single-stage compressor or low-pressure cylinder of a multi-stage machine is seldom less than 3 to 4 per cent. of the volume swept out by the piston. It is usually found that, within limits for practical reasons, the larger the machine, the smaller the percentage clearance.

If a single-stage machine were constructed to compress to a moderately high pressure, say, 165 lb. per square inch, the indicated volumetric efficiency at the best would not be more than about 80 per cent., whilst the ratio of volume of free air delivered to volume swept by piston would be very much lower still, due to the addition of heat before compression commenced. Further, the cross-head loads would be very great, due to the final delivery pressure being exerted on the whole area of the large piston. The twisting moment diagram for the machine would be uneven, and, perhaps of most consequence, the final delivery temperature would be excessively high.

If, on the other hand, the same size of cylinder were used with a high-pressure cylinder added thereto, so that the first only compressed to 37 lb. per square inch, the indicated volumetric efficiency would be increased to about 94 per cent., due to the lower delivery pressure bringing the point of the low-pressure diagram corresponding to E in Fig. 8 nearer to A. With the high-pressure cylinder mounted in tandem with the low-pressure, it is possible that the weight of the machine per unit of air delivered would not be more than when the compression was carried out in one cylinder. Staging nullifies to a large extent the effects of clearance volume on the volumetric efficiency of a compressor, besides obviating the difficulties with loads and temperatures.

In both the French and German languages the expression for clearance volume, literally translated, means "injurious space," yet the effects of clearance in some cases are beneficial. In a cylinder with no clearance the whole load at the commencement of the stroke due to the acceleration of the moving part comes upon the crank-pin. With clearance, the re-expansion of the clearance air helps largely to accelerate the masses, and an interesting case in this connection may be cited.

With steam-driven compressors it is common practice to mount the steam cylinders in tandem with the air cylinders, in which case the setting of the steam valves must be so arranged that admission is late instead of early, as is usual. If the full steam pressure were applied to the piston before the clearance air pressure in the air cylinder had become reduced by re-expansion, unnecessarily high loads due to these simultaneous full pressures, less the inertia effects, would be imposed upon the connecting rods, etc. High speeds with increased inertia forces tend generally to reduce crank-pin loads. With steam-driven compressors of the foregoing type the greater the clearance volume of the air cylinder the later must the steam admission be timed.

Effects of Clearance in the Higher Stages of a Multi-Stage Compressor

In a multi-stage compressor the work done in the various stages may be varied within fairly wide limits merely by adjusting the clearance volumes of the various cylinders, excepting the low pressure. Suppose, for example, it is required to reduce the proportion of work done in the high-pressure stage of a three-stage compressor in which the high-pressure clearance volume is 10 per cent., and with stage pressures—low pressure 45 lb. per square inch, intermediate pressure 300 lb. per square inch—working against a final delivery pressure of 900 lb. per square inch.

The work done in compression varies as the ratio of final to initial pressure, so that any desired reduction in any given stage can only be effected by reducing this ratio, or in this case by increasing the high-pressure suction pressure, since the final delivery pressure is fixed. The compressor capacity being unaltered, an increase in the high-pressure suction pressure necessarily involves a corresponding reduction in actual volume of high-pressure suction. Since the volume swept by the high-pressure piston remains the same, it is clear that the only way to ensure a reduced suction volume is to decrease the volumetric efficiency of the high-pressure cylinder by increasing the clearance volume, with the result as shown in Fig. 9, where the high-pressure diagram with the original 10 per cent. clearance, together with the diagram resulting from an addition of 20 per cent. extra clearance, are given. The area of the diagram is considerably reduced, the high-pressure suction pressure (the intermediate-pressure delivery pressure) rises from 300 lb. per square inch to 375 lb. per square inch (gauge-pressure), this increase being necessary in order to get the whole of the air into the high-pressure cylinder. The effect on the low-pressure delivery pressure is slightly to increase it, due to the reduced volumetric efficiency of the intermediate pressure cylinder, resultant upon the expansion of the intermediate pressure clearance air from a higher pressure. The actual increase in low-pressure delivery pressure depends upon the intermediate pressure clearance volume. If the intermediate pressure cylinder had no clearance volume, which is impracticable, the low-pressure pressure would remain unaltered. The slight increase in low-pressure delivery pressure somewhat reduces the volumetric efficiency of the compressor.

The simple method of altering the distribution of work would be convenient where the high-pressure delivery temperature was found to be excessive (see later), or in cases where the turning moment was unsatisfactory. The clearance volume can be increased by the addition of a hollow pocket, but cannot so easily be reduced.

Some multi-stage compressors are required to work for long periods at varying delivery pressures, or, in the case of a charging compressor, at a constantly increasing pressure from atmospheric to the full bottle pressure. With Diesel engines it is usual to regulate the blast pressure by throttling the fuel-injection

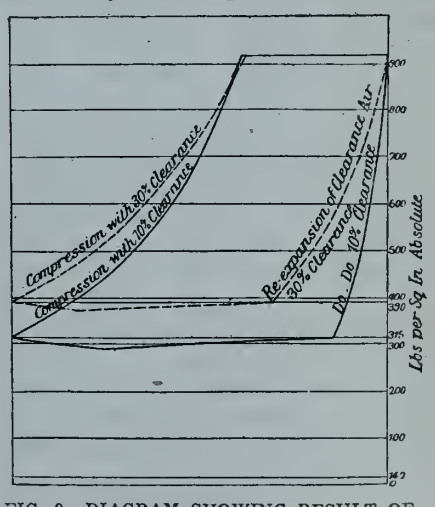


FIG. 9. DIAGRAM SHOWING RESULT OF INCREASING CLEARANCE VOLUME IN HIGH PRESSURE CYLINDER.

air compressor suction, so that instead of compressing and blowing the excess to waste, only the requisite amount is dealt with. The effect on the distribution of work, temperatures, etc., occasioned by

this throttling should be considered—especially with marine engines, where the compressor may run for long periods in this condition.

In all machines there are certain stage pressures which give the best all-round running, as regards temperatures, loads, balance, etc., for each delivery pressure. If these stage pressures are accurately determined for the normal final delivery pressure, then it is safe generally to assume that the particular stage division of work so obtained will also be the best proportion for any other delivery pressure at which the machine is likely to work. With Diesel engine fuel-injection compressors this state of affairs rarely obtains. In a three-stage compressor designed for 800 lb. per square inch working pressure, and run at, say, 900 lb. per square inch, the low-pressure and intermediate-pressure pressures will not increase in proportion to the final delivery pressure—actually in the majority of cases they alter little. By suitably proportioning the cylinder clearance volumes of the various stages the machine can be made automatically to divide the total work between the stages in a given proportion, no matter what the delivery pressure may be.

Figs. 10 and 11 show approximately the stage pressures which would be obtained in three machines of the same capacity when working at different pressures. Each machine is designed for a delivery pressure of 900 lb. per square inch, and at this pressure the stage pressures are: low-pressure, 45 lb. per square inch (gauge pressure). The heavy lines on the diagram show what the pressures should be to secure an approximately constant proportional division of work between the stages. The lines marked (a) show the pressures which would obtain in a compressor having cylinder clearances of: low-pressure, 4 per cent.; intermediate-pressure, 5 per cent.; high-pressure, 10 per cent.

The rise in the stage pressures as the final delivery pressure increases is seen to be comparatively small. The lines marked (b) show the pressures with a compressor of the same capacity when the cylinder clearances are: low-pressure, 4 per cent.; intermediate-pressure, 10 per cent.; high-pressure, 20 per cent. Here it is seen that the rise in stage pressure is much more marked than in the first case, that is to say, with these increased clearance volumes the proportional division of work between the stages is more nearly constant than with the smaller clearances. The lines marked (c) give the pressures which would obtain with a machine having clearances: low-pressure, 4 per cent.; intermediate-pressure, 15 per cent.; high-pressure, 30 per cent.

In this case the rise in stage pressures as the delivery pressure increases approximates much more nearly to the "ideal;" that is, the proportional division of work between the stages is very nearly constant, so that the balance of the machine is more likely to be maintained than in the first case, and, further, the final delivery temperature will be lower, for in the first case, when the machine is working at a pressure higher than its designed pressure of 900 lb. per sq. inch, the high-pressure stage is taking more than its designed share of the work. For example, if the first machine (case "a") were run at 1,200 lb. per square inch, the compression ratio in the high-pressure cylinder would be:—

$$\frac{1215}{335} = 3.63$$

If the last machine (case "c") were run at 1,200 lb. per square inch, the high-pressure compression ratio would be:—

$$\frac{1215}{370} = 3.28$$

This means that the temperature attained in the machine with the large clearance would be less than in the machine with the small clearance on account of the smaller compression ratio. Furthermore, if the large clearance is composed of a connecting pipe within a water-jacket, as is sometimes the case, the cooling during compression is improved, resulting in a decrease of the value of "n" in $PV^n = \text{constant}$, still further reducing the temperature. Again, the clearance space being so efficiently cooled results in an increase in the value of "n" for the re-expansion of the clearance air. The incoming air mixes with this comparatively cool air, and consequently the initial temperature is not unduly raised.

The main point, however, is that by correctly arranging the clearance volumes the machine can be made to divide the total work into the best proportions for any delivery pressure with which the compressor may have to deal. A minor point is that with increasing delivery pressures piston leakage becomes greater, and the volumetric efficiency at the higher pressures is less than at the lower. If the low-pressure pressure increases with the delivery pressure, the indicated volumetric efficiency of that cylinder is decreased in addition—or, in short, the overall volumetric efficiency of the machine with the big clearances is slightly less than that of the machine with the small clearances when the delivery pressure is higher than that for which the compressor is designed.

The difference, however, is not worth considering. (It may be mentioned that the lines in Fig. 10 should not actually be quite straight. They are sufficiently accurate, however, as in practice it is impossible to estimate the pressures to within a few pounds.)

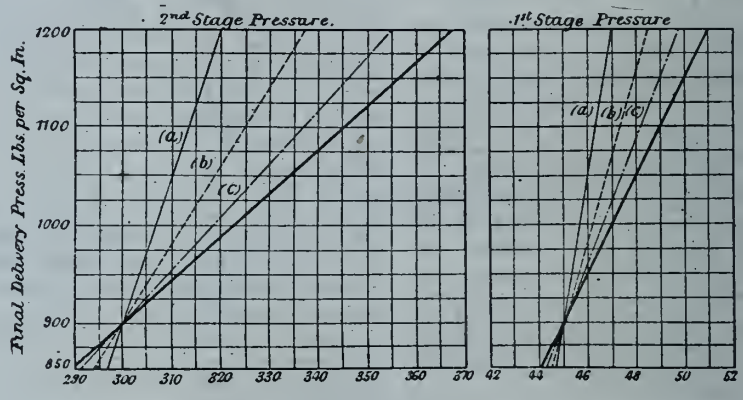


FIG. 10. FIG. 11.

DIAGRAM SHOWING APPROXIMATELY THE STAGE PRESSURES ATTAINED WHEN THE COMPRESSOR IS DELIVERING AGAINST DIFFERENT FINAL PRESSURES.

Each machine is designed for a final delivery pressure of 900 lbs. per square inch with L.P. and I.P. pressures of 45 lbs. per square inch and 300 lbs. per square inch respectively.

(a) For a compressor whose clearance volumes are: L.P., 4 per cent., I.P., 5 per cent., H.P., 10 per cent. of volume swept by piston.

(b) For a compressor whose clearance volumes are: L.P., 4 per cent., I.P., 10 per cent., H.P., 20 per cent. of volume swept by piston.

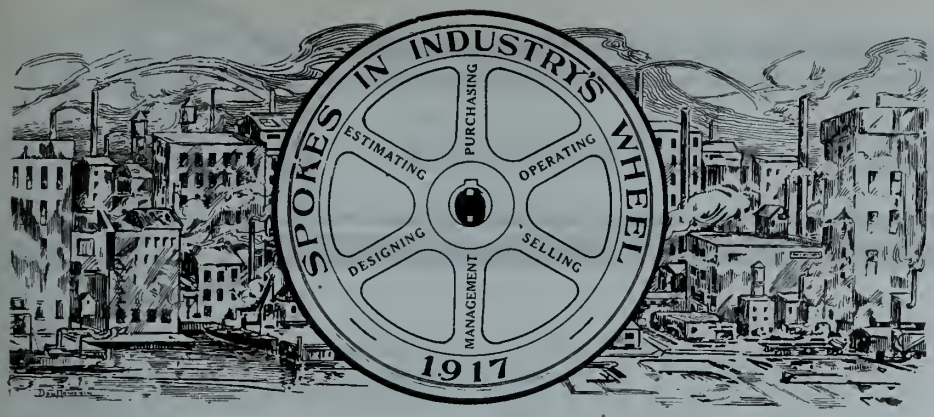
(c) For a compressor whose clearance volumes are: L.P., 4 per cent., I.P., 15 per cent., H.P., 30 per cent. of volumes swept by piston.

The heavy line shows what the pressures should be if the division of work between the stages is to remain in the same proportion for all delivery pressures.

THREE-CYLINDER COMPOUND ELECTRICAL UNIT

THE new 60,000 kilowatt unit to be installed in the 74th Street station of the Interborough Rapid Transit Co., New York, where three 30,000 kw. cross compound Westinghouse turbine generators have been in successful operation for over two years, will consist of a high pressure and two low pressure turbines, each coupled to a generator. Each of the three turbo generators making up the unit is to have a governor so arranged that if for any reason the circuit should open on the high pressure turbo generator, steam will be shut off from that particular one, and the two low pressure turbo generators will operate under governor control with high pressure steam. Likewise, should anything happen to both the high pressure and one of the low pressure turbo generators, or to the two low pressure turbo generators, the remaining one will operate and carry the load. The turbines which will operate at 220 lbs. absolute steam pressure, 120 degrees superheat, 20-inch vacuum, and the generators which will have a capacity of 60,000 kw. continuously, or 70,000 kw. for two hours, are being furnished by the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa.

A person don't mo'n realize he's a descendant befo' he's a' ancestor.—Ruth McEnery Stuart.



The constitution of industrial enterprise is largely departmental—"Spokes in a Wheel." This series has for its object the featuring of, in racy, interesting and instructive fashion, the training, experience and achievement of those who to-day are transmitting effectively, energy in a variety capacity as "Spokes in the Wheels" of steam, electrical and hydraulic and refrigeration engineering.

JOHN WILKIE TAYLOR

THE increasing importance of the shipping industry, which is now being brought before the general public by events not of the pleasantest, is of more than passing interest to our readers, not only on account of the manufacturing activity which is expected to result from present developments, but also because of the more intimate knowledge ensuing with regard to ships' equipment and personnel. The part played by the machine shop in the annual round of marine life in this country is too important to be overlooked. Not only so, but the influence of early experience during the formative period of an engineer's life has more than a little to do with the ultimate niche which he may occupy in industry's gallery.

As chief engineer of the Western Canada Flour Mills Co., Goderich, Ont., John Wilkie Taylor occupies a post of considerable importance not only from a technical viewpoint, but also, at the present moment, from a standpoint of international exigency; a daily capacity of 10,000 barrels of flour by the various plants will perhaps facilitate perception of the reference. Despite the fact that he has a "shore job," Mr. Taylor's success has been largely influenced by a happy combination of constructive and operative experience. Born of Scottish parents at Nottawa, Ont., 1868. Mr. Taylor is Canadian to the core, his life activities having afforded opportunity for becoming intimately acquainted with many widely separated parts of his native land.

His early education was obtained in the public schools of Nottawasaga Township, passing the entrance examinations at 13 years of age. In May, 1880, an apprenticeship was commenced in the establishment of Nathan Veitch, ironfounder and machinist, at Nottawa, and although, as our "Spoke" remarks, the plant was somewhat primitive, the proprietor, by reason of his personal interest in the youthful employee, more than made up for the shortcomings of his equipment. Mr. Veitch was a real "old guard" of the trade, having come from the Howden shops in Glasgow, Scotland, and the thorough manner in which he grounded our friend in the rudiments of the foundry and mechanical trades has been the cause of life-long gratitude on the part of Mr. Taylor.

On the conclusion of his apprenticeship Mr. Taylor spent a year at Collingwood as assistant engineer in a large saw mill owned by the A. M. Dodge Co.,

JOHN WILKIE TAYLOR.

of New York. His contact with shipping at this port created a desire for marine experience, and during the three seasons ending 1890 he was in charge of small craft plying from that port. A position as staff engineer with the Great Northern Transit Co. of Collingwood was followed in 1894 by appointment to the post of chief engineer in charge of the fleet of the Dominion Fish Co., Georgian Bay. This position he relinquished for a year to join the Holland and Emery Lumber Co., at Byng Inlet, returning to the former company and superintending the overhauling of their fleet while wintering at Goderich. The year 1900 was rendered memorable in our "Spoke's" life by the burning of the passenger steamer Persia, of which he was chief engineer. The event was not without its recompense, as he had full charge of the rebuilding of the engines, boilers and mechanical equipment, a task which was of considerable value in view of the experience obtained, as was evidenced by the performance of similar work for the Dominion Fish Co., in connection with their passenger steamer Manitou.

Recent events have acted as a forcible reminder of the three years from 1904 to 1907, which were spent as chief engineer on the steel freighter Algonquin, this craft having recently fallen a victim to the torpedo of a Hun submarine off the coast of England. Mr. Taylor at this time was a strong advocate for the adoption of quadruple expansion engines, and while a bulk lake freighter of 10,000 tons was so fitted at that time and demonstrated the efficiency of the type of engine, further adoption was negatived by the extra amount of space required. His admiration for this highly developed type of engine was given full scope, when after four years with the Montreal Transportation Co., he became chief engineer of the turret steamer Scottish Hero, of the Canadian Lake & Ocean Navigation Co. This vessel had quadruple expansion engines, and had been refitted with Scotch boilers for 215 lbs. pressure, the two years' operation of which provided additional experience of a valuable nature, calculated to render our friend particularly fitted for the control and direction of the extensive equipment for which he is now responsible, and to which he was appointed in 1913, resigning from an important appointment with the Merchants' Mutual Line to accept the position.

The practical experience outlined has been combined with frequent opportunities to study power plant conditions in the States as well as Canada, and Mr. Taylor speaks highly of the degree to which Western Canada industrial equipment has been developed. A feature of Mr. Taylor's success has been the extent to which he relied on self-tuition for acquiring his theoretical knowledge. During early days in lake service, the winter months were spent in machine shops, and evenings devoted to study, the benefits being evidenced by the steady progress in his profession. His advice, therefore, to the young stationary engineer has the feature of personal success behind it. "I most strongly advise serving an apprenticeship in some good engineering shop along with a technical school training, and throughout life a diligent study of trade and engineering journals.

As is frequently the case with men

(Continued on page 148.)

Electricity and Hydraulics

BRUSHES FOR COMMUTATORS AND SLIP RINGS

THE nearly universal adoption of commutating poles, together with increasing commutator speeds and increasing brush densities, has made the problems of producing and selecting proper brushes for commutators and slip rings of importance of the first magnitude, says Charles H. Smith, Engineer, Executive Department, Westinghouse Electric & Mfg. Co., in The Electric Journal.

Brush Composition

Brushes are composed principally of: Carbon, carbon and graphite, graphite (natural), electro-graphite, metal and graphite (metal-graphite), carbon and wire gauze, copper leaf.

Carbon is a non-metallic element found in all organic substances, and for commercial purposes in anthracite and other coals and in charcoal. The amorphous or uncrystallized form includes charcoal. coke, lampblack, etc.

Graphite (natural), also known as black lead and plumbago, is a crystalline form of carbon. It is found in many forms and is widely distributed, Ceylon being perhaps the chief source of that used in commerce.

Electro-graphite (artificial graphite), is prepared commercially by heating coke (or other amorphous carbon) in an electric furnace and converting it from the non-graphitic to the graphitic state.

Combinations of carbon, carbon and graphite, graphite, and in some instances pulverized copper, are mixed with, or without, abrasives and binders, extruded or pressed into shapes varying from the size of the finished brush, to blocks and slabs of many forms and dimensions, which are baked or burned for use as brushes. The blocks and slabs are subsequently sawed and ground into sizes to suit the market demands. Brushes may be ground to almost any shape and can be furnished in block shape, bare or copper coated, drilled for, or fitted with, shunts, milled to the angle or radius to fit the commutator or rings, fitted with caps to protect the tops from the pressure springs and, if desired, equipped with almost any supplied or specified brush-lifting clips or devices.

The baking of the brush material is subject to many of the difficulties encountered in baking or firing earthenware. It is well known that a large piece of crockery or earthenware is more difficult to produce than a small piece, the reason being that there is more material and, consequently, more likelihood of warping, cracking, etc., from uneven burning or firing. The same troubles occur with brush material. It is obvious, therefore, that brushes made from small blocks, bricks, or slabs, or carbon, are more likely to prove uniformly good, or homogeneous, than brushes made from larger sizes of the same materials and mixings.

"Capping" and "Coating" Brushes

Soft brushes require protection from the wearing effect of the tension spring hammer. This protection consists of a metal cap which may cover the entire top of the brush, or merely that part upon which the spring presses. It frequently happens that the resistance between the brush and holder is less than that between the brush and shunt. As a consequence, the function of the shunt is usurped by the holder and the tension spring, resulting in the burning of the brush sides and in the destruction of the spring. This indicates that the cap should be integral with or attached to the shunt, or that the shunt attachment is defective. The definite way to preclude this too frequent possibility is to devise means to cause the shunt to perform the function of carrying the total, or substantially the total current handled by the brush. Fundamentally, such a means is in no sense an impossibility, and sooner or later will, no doubt, be put into practical form. The sooner, the better.

If the shunts perform their function properly there is no electrical reason for copper coating the brushes (unless it be immediately under the shunt, for the purpose of improving the contact between the shunt and brush), and less reason for the subsequent tinning of the copper. In case the brush is soft, or mechanically weak, it is desirable to protect it from mechanical shocks, and from wear due to rubbing against the sides of the holders and against the brush tension springs. For this purpose a copper or tinned copper coating is desirable.

Terms Used in Connection With Brushes

The following explanations of a few of the more important terms used in connection with brushes may prove instructive:—

Contact Drop refers to the drop between the brush and the commutator. The contact drop differs with different materials, different brush pressures and different loads. For a given material and given load the contact drop decreases with increased pressure and increases with the load. It varies but little with changes in speed above 2,500 feet per minute, and but little with temperature changes under normal conditions. Presupposing that the brush and spring pressures are identical, the contact drop between the commutator and positive brush differs from that between the negative brush and commutator on any given machine.

Brush Friction.—The coefficient of friction depends upon the brush material, brush angle and commutator speed. With a given material and brush angle, the coefficient of friction increases with load and brush pressure and, generally speaking, decreases with increased commutator speed. Increased temperatures, in actual practice, justify the conclusion that the friction coefficient increases with increased temperatures.

Specific Resistance.—The ohmic resistance of a cube having one-inch sides.

The Current Density (or carrying capacity) of a brush is based on its maximum continuous current capacity per square inch, without glowing, honeycombing, undue heating, or sparking.

Glowing.—A brush is said to "glow" when it becomes red or incandescent in spots in proximity with the commutator. This is due to the short circuiting current under the brush or to the short circuiting current in combination with the working or kilowatt current. It may also be due to a lack of homogeneity of the brush (hard or soft spots of the same or different materials having characteristics foreign to the material in the body of the brush); to incorrect brush position; to improper brush selection; to selective commutation; to the brush covering too many bars; to high mica; to the machine having inherently poor commutating characteristics due to improperly shaped or spaced main poles or commutating poles; to bad commutating pole adjustments, or to a poor distribution of armature windings. In event the glowing cannot be stopped by

JOHN WILKIE TAYLOR

(Continued from page 147.)

much occupied in industrial pursuits, Mr. Taylor has not spent much of his time in political matters, being strictly independent in his views. He has, however, been a life-long member of several fraternal socities and a number of Masonic orders, and when he retired from lake engineering was made an honorary member of Midland Council, National Association Marine Engineers.

Mr. Taylor's private life is now spent at Goderich, where he resides with his wife and family on Lighthouse Street, his ability having descended to one son, who is serving in an engineering capacity with the Standard Oil Co. at Taft, California.

correcting such of the brush or mechanical troubles as may exist; or by shifting the brushes, or readjusting the commutating poles, or both; a brush having higher current density values and less susceptible to the effects of high voltages between the commutator bars should be installed. If a suitable brush cannot be had, the design of the machine itself may be subject to modification.

Honeycombing.—When brushes gradually burn away, forming small craters in their faces, they are said to "honeycomb." This is due to continuous sparking of a more or less hidden nature and may be either a slow or rapid nature. If the growth is slow, it is sometimes possible to correct it by increasing the brush pressure, thereby decreasing the contact drop and the contact arcing, and at the same time increasing the abrasive effect of the brush and grinding away the minute craters as they form. Honeycombing is due to the same causes, on a reduced scale, as glowing, and at times both may take place simultaneously on the same machine. Honeycombing has been traced directly to high mica in combination with loose commutators; also to improperly spaced main poles; and unequal air gaps; and in non-commutating-pole machines, to an abnormal shifting or distorting of the magnetic flux. The trouble is most frequently corrected by substituting a more highly refractory brush possessing abrasive characteristics.

Hardness.—Brushes have widely varying physical densities—some being very hard, others very soft. Very hard brushes usually carry a large amount of abrasive and have a low current density or carrying capacity. The softer brushes are more highly graphitic, carry abrasive to a limited extent only and have a high current density. The hardness or scleroscope reading is, therefore, indicative to a limited degree of the character of the brush.

Brush inertia has to do with the weight of the brush. The lighter the brush, the more readily will it follow the irregularities of the rotating element, and the more promptly will it respond to a given spring pressure. Again, the wearing on the commutator may not prove so great. If a light and a heavy brush prove equally satisfactory electrically on a machine, the lighter brush is preferable. If the materials from which brushes are made are heavy, it is advisable to have an increased number of small brushes, rather than a limited number of large brushes; also the spring pressures should be in excess of the pressures on lighter brushes having the same dimensions, and used for the same service.

Refractory.—Any material which resists the ordinary methods of reduction is said to be refractory. A brush, therefore, which resists wholly, or to a marked degree, high temperatures, such as heat generated by an electric arc, is said to be highly refractory.

Peripheral Speed is the speed in feet per minute of the face of the commutator or slip ring. Peripheral speeds which vary greatly require brushes having different characteristics. Generally speaking, carbon brushes are not so suitable for high peripheral speeds as graphite brushes.

HYDRO-ELECTRIC BUYS OUT ONTARIO POWER CO.

SIR ADAM BECK announced this month that the Hydro-Electric Power Comission of Ontario has acquired the assets of the Ontario Power Co. for $22,669,000 on the following terms:—

The company agrees to deliver all its Canadian properties, along with all its physical assets and contracts for the delivery of power, in return for which the commission agrees to pay in its own debentures to the extent of $8,000,000 for the $10,000,000 of stock now held by the company, and to assume the bond liability of $14,669,000 secured by a first mortgage on the property. The company is to receive the current assets and to assume the current liabilities.

The Hydro-Electric Commission will take possession of the property on the first of August. The municipalities will get their power at nine dollars per horsepower, and even selling power at that low figure it is estimated the plant would pay for itself in twenty-five years.

The principal owner of the Ontario Power Company was John Joseph Albright, of Buffalo, N.Y., who agreed to sell to the Hydro-Electric Commission ninety thousand shares of the company's stock at $80 per share. The shares have a par value of $100 each, and Mr. Albright has undertaken to accept as payment Hydro-Electric four per cent. forty-year bonds. There is now invested in Hydro property in this province practically seventy million dollars, including money put in by the municipalities.

Estimates made by the Hydro-Electric Commission's technical advisers, headed by Fred Gaby, chief engineer of the commission, show that the estimated revenue per annum from the sale of power is $2,396,277; the operating expenses, rentals, taxes, etc., will be $804,718; the fixed charges, interest on bonds, sinking fund, etc., will be $990,550; the total operating expenses, $1,795,268, leaving a balance of $601,009 for the year. From that will have to be deducted interest and sinking fund on the $8,000,000 worth of Hydro bonds, which will amount to $400,000, leaving a balance for depreciation of $201,009.

ELECTRIC HAZARDS*

By D. M. Petty.**

ELECTRIC hazards, accidents, risks dangers, or whatever one chooses to call the possibility of getting hurt by electricity, can be divided into four classes in general accordance with the way one is liable to receive an injury.

The first division is made by dividing all hazards in two classes according to voltage, namely, high and low voltage hazards. Each of these two divisions may well be divided into two classes according to the manner in which the injury is received, namely, shocks and burns.

With low voltage we hear more of burns than of shocks, while with high voltage the reverse is true. It is also true that while there are many more low-tension shocks than burns, they are not so serious, while with high tension a shock proves fatal much more often than the burns with low tension.

Shocks From Low Tension

Personally I do not know of a single case of persons being shocked to death with less than 300 volts. There are, however, cases on record where men have been shocked to death by 110 volts. The doctors tell us that a man with a weak heart is in danger when receiving a 220-volt shock, and it is well for us to believe it. We can, however, say that 220 volts will not endanger the lives of men when working on a dry wood floor, unless the man gets good contact on both sides of the line. We can also say the same thing with a little less margin of safety of a dry concrete or tile floor. A metal or wet earthen floor, however, provides a good contact for the man standing on it, and he is in much more danger. So far as shocks are concerned with 220 volts, we may consider men as normally safe, and extreme precautions are not necessary.

Burns From Low Tension

Burns from electric arcs may be divided into two general classes. The first are those caused by short circuits or ground, occurring during construction or repair work. A burn of this kind most frequently comes from accidental contact with both sides of the line with a screw-driver, pair of pliers, or other tool when an electrician is making a connection.

The hazard in this case is directly dependent on the man. A careless man will get burned often, while a careful man will work for years without a single accident.

It would be extremely conservative to forbid connections, disconnections, or repair work on 220 volts and lower when alive, and the writer does not feel it is necessary or even a desirable step to recommend. The only means that will prove really beneficial to the man, the apparatus and the company for whom he works, is care. Train the electricians to be careful.

The second class are the burns which occur in the vicinity of open fuse blocks. These blocks are usually spaced close together and often on the live side of the switch. The object of putting fuses on the live side of the switch is to protect the circuit against a short circuit in the switch, but these are so infrequent that it is better to arrange the fuses on the dead side of the switch.

Prevention of Accidents

As to prevention of this class of accidents, the following suggest themselves as remedies: Train the men to be careful. Eliminate as far as possible work on live parts, such as fuses, by putting the fuse

*Proceedings of Fifth Annual Safety Congress, National Safety Council.

**Superintendent Electrical Department, Bethlehem Steel Co.

on the dead side of the switch. Use tools with insulated handles where possible. Use enclosed fuses in place of open link type. Use circuit breakers.

The second class of burns differs from the first more in the nature of the men who are burned than in any other point. They are not the electricians, but the shop and mill men. This class includes short circuits in hand lamps, lamp cords, lamp sockets, rosettes, and now and then a bad fuse.

The following "Dont's" would help to reduce accidents from this hazard:

Don't put in a fuse unless you know why it burned out. Call the electrician.

Don't drag extension lamp cords around on the floor.

Don't play with switches.

Don't try to "fix" the motor or the lights, let the electrician do this—it is his job.

At this point it is well to take up the much-discussed question of enclosing low-tension circuits.

Few, if any, men are killed from the shock of 250 volts or less. Most men who lose their lives, due either directly or indirectly to shocks, receive such shocks from trolley wires in some elevated position and fall some distance.

Burns usually come from some attempt on the part of the man burned or a fellow workman to repair or adjust live parts.

It would seem, therefore, that there is no necessity for going to any great extreme in totally enclosing low voltage. Because:

1. Parts that need adjusting or repairing must be uncovered before such repairs or adjustments are made, and the same hazard for a short would exist after enclosing as before.

2. Trolley wires and such bare lines cannot be enclosed without making it very difficult to instal or repair same.

It seems to the writer that the proper course to follow is what may be termed a "middle course"; that is, enclose parts that the machine operator must handle to properly do his work and design the rest of the layout to avoid short circuits to the electrician and forbid others handling in any way this part of the apparatus.

Take, for example, a motor-driven lathe as a typical machine:

Following in through the power lines, we come first to the circuit breaker. By properly locating this and by using a design with both sides of the line separate, it is unnecessary to enclose it even in an iron box. The arcing tips should be so arranged that the arc flies up, and should a short circuit exist in the wiring, by closing one side at a time the breaker will open when the second leg is closed and will not hurt the operator.

Next we come to the controller, which is usually located in an out of the way place, and must be enclosed for its own sake.

Then we come to the motor, which is usually of the open type. If the operator is allowed to adjust, or, rather, as the case usually proves, disadjust the brushes, he will at times receive shocks and may get burned by short circuiting a tool of some kind from one brush holder to another of opposite polarity.

If magnetic or so-called automatic starters are used, it is not necessary, unless desirable from a "dirt" standpoint, to enclose the contractors or resistors.

High Voltage

In passing from low tension to high tension, the character of the hazard changes with increasing potential from burns to shocks. From 440 volts up the shock is to be considered dangerous, and while it may be said that a fairly small percentage of those receiving shocks of even 500 volts are killed, yet the fatalities are high.

Shocks from high voltage may be divided into two classes: Contacts with bare parts of a circuit; breakdown of parts supposed to be insulated.

In the first class come contacts with transmission lines, which are and should always be run with bare copper, busses in the power stations, choke coils, switch parts, etc. A large majority of these shocks are due to the old excuse, "Didn't know it was loaded," and are properly classified as carelessness.

All high-tension apparatus should be, and usually is, built so as to prevent the man from handling live parts when things are in normal operation, and it is seldom, if ever, that a man is shocked to death under these conditions.

Repairs and Adjustments

Most danger lies in making repairs and adjusting apparatus and in so-called temporary work. One of the greatest contributing factors in this dangerous work is some man throwing the wrong switch, energizing a circuit or wire on which other men are working.

The parts being worked on should always be carefully grounded.

One man should attend to the closing of switches.

One man should have charge of the job in hand.

When working on live parts, a carefully designed barrier will prove effective against the opposite polarity, and a well-insulated platform should be used to work from.

Rubber gloves are unreliable and should be used with great care. They may be used for pulling line fuses, etc., where a proper hook stick is also used.

In the second class of high-tension hazards, both the electrician and the operator are subject to the danger of some part of the insulated circuit breaking down and charging a part of the apparatus that is normally safe. One of the most dangerous points in this connection is the step-down transformer. The high-tension primary may break through the insulation and charge the low-tension secondary with high voltage, and thus impose high where only low tension is supposed to be.

The manufacturers as well as users of transformers have always paid a great deal of attention to this one point, and it is seldom a break occurs outside the test room of the manufacturers or during a lightning storm.

When we have discussed shocks from high tension, the hazards of that division are almost covered, for while we may have shocks without burns, it is almost impossible to have burns without shocks on a high-voltage circuit. Contact with both sides of the line is less liable to happen on account of the greater spacing of parts with high tension and the current available to make an arc is less than with low tension. Reduction of accidents in the electrical field is dependent on the extent to which we can impress the men to be careful and is, therefore, no different from other lines of work.

There is one more point, however, that should be brought out very strongly for the benefit of the workmen rather than the electricians, and that is to let electrical apparatus and wires alone. When there is trouble, call the electrician.

NIAGARA FALLS POWER CO. REPORT

THE pamphlet report of the Niagara Falls Power Co., for the year ending Dec. 31, 1916, says that all permitted means have been taken to meet the rapidly-increasing demand for power. Two additional generating units in the Canadian plant have been completed and placed in service. A third unit is now in process of being added. The management points out that the rapid increase in power use in Canada has led the Government to reduce considerably the permits for the exportation of Niagara power, and adds:—"The export license of our Canadian company has been reduced from 75,000-horsepower to 30,000 horse-power. We have, therefore been obliged to withdraw 45,000 horse-power from American industries, despite insistent demands."

ELECTRICAL QUERIES AND REPLIES

Question.—Define the terms Volt, Ampere, Ohm, Watt, and explain their relationship to electrical horse-power?—M. A. C.

Answer.—The volt is the unit of measurement of force, or strength of electric current, commonly known as electromotive force, or E.M.F. The ampere is the unit of measurement of electric current quantity. The ohm is the unit of resistance to a current passing through a unit length of wire of unit diameter; and the watt the product of one volt and one ampere = volts × amperes. An electrical horse-power = 746 watts, which is equivalent to that of the steam engine, viz., 33,000 foot pounds.

* * *

Question.—What means are employed to prevent any part of an electrical circuit from becoming overheated?—P. H.

Answer.—A fusible cut-out or fuse which consists of a strip of lead or other readily melted substance is introduced at a convenient point. Then, if from any cause the current becomes greater in intensity than the lead and its connections can comfortably and safely stand, the fuse owing to its resistance becomes overheated and melts, thus breaking connection and preventing overheating of parts in the circuit beyond.

REFRIGERATION DEPARTMENT

DIFFERENCES IN QUALITY OF AMMONIA*

By A. Johnston

MANY users of ammonia imagine that "Ammonia is Ammonia"—meaning that as far as they are concerned, all brands of ammonia are alike in quality, possibly because all brands smell so pungently strong as to divert the mind from any other quality, except the odor, leaving all thoughts of other factors so necessary to efficiency, in the background. "Ammonia is Ammonia"—which of course is not true as can be proven by the late report of the U.S. Bureau of Standards, as read before the American Society of Refrigeration Engineers in New York City last December. They did not jump to conclusions for it required several years time to study, test and report on eight different American makes of commercial anhydrous ammonia direct from the original cylinders. All contained impurities, some more than others; for instance the amount of volatile carbonaceous matter (which is a very harmful impurity even though in small quantities), was present in every one of the eight brands—only some had much less than others.

Differences in Ammonia

Why such differences should occur can partly be explained by the various methods of manufacture by the eight different makers. Each one thinks he has the best apparatus and process and that is quite a natural thought. Then again there are two widely different methods of making ammonia—one is called the "sulphate process"—the other is called the "direct process." To briefly explain:—The sulphate process depends on using salt called sulphate of ammonia. The ammonia gas contained in the crude gas house liquors is absorbed in sulphuric acid and in forming itself into a crystal is subjected to nature's powerful purifying process—the crystals are then converted into a very uniformly pure ammonia gas and sold to the public.

The "direct process" distills the ammonia direct from the crude gas house liquors without going to the troub e and expense of crystallizing it in sulphuric acid to remove impurities. It is a cheaper and quicker process, and is the common process in use to-day. Some day we may add another process called the synthetic process which produces ammonia bv snatching the raw materials from the atmosphere and water, this is not yet in commercial use so we will not dwell on this "air snatching process," except to mention it as a future possibility.

In addition to the two widely different processes, each maker no doubt has little inventions of his own, brought about by experience, troubles and necessity—so that it is not to be wondered at that a volatile product like anhydrous ammonia should differ in quality. Think how difficult it is for eight differently constructed distilled water ice plants in eight widely separated districts, under eight different engineers, to even make a non-volatile product like distilled water come out the same—for instance—some would be better than others, some would have oil in it—some would have air in it—some would be colored red, yellow or green—when frozen some would have a bad taste, due to bad arrangement of steam condensers or naturally bad weather—some would have no oil, odor, no r bad taste in the water.

Personality and Ammonia

The foregoing may be claimed to be due to the element of the personal equation because some men can make sweeter and cleaner distilled water than others—which is quite true, and the same argument holds doubly good in the art of ammonia manufacture, for ammonia is a highly volatile compound and must be kept within pipes or closed vessels, whereas distilled water is liquid under ordinary conditions and can be examined any time and is more easily made.

If then, it is so hard to make ordinarily distilled water alike, how much more difficult it must be to make all ammonia alike in quality, yet some people still believe that all ammonia is alike, not only operating engineers but even consulting engineers who are supposed to use their heads instead of their hands.

Each manufacturer naturally swears by all the prophets that his ammonia is "the best," that meaningless and timeworn expression—"the best," means nothing, for every one knows that all the shades of quality are disguised as "the best" and there is nothing to prevent any maker claiming it, whether it is so or not—that occurs not only in the ammonia line but in other lines.

The old time evaporating test with a bottle has been found to be no criterion as to purity of the gas but is very good to find such things as water, oil or other non-volatile matter. The volatile impurities pass out of the test bottle and are lost in the air. The working test is the best but you should always show enough interest to find out by which process your ammonia is produced, whether by the sulphate process or the direct process, or whether made by a teamster or a chemist, or any other point you can ascertain, preceding the manufacture, not afterwards. Any or all of these points have some bearing on the quality expected in such a highly volatile product.

You will find that a "sulphate made" ammonia is more uniformly pure and comparatively free from harmful carbon compounds if properly made. All ammonia will refrigerate more or less, but when it contains carbon impurities its efficiency is reduced and high power bills created. High power bills waste dollars and cents.

Ideal Pure Anhydrous Ammonia

The ideal pure anhydrous ammonia should consist of two colorless, tasteless and strange to say, of two absolutely odorless gases, called nitrogen and hydrogen. (One is the laziest, the other is the most active gas—chemically speaking). The odor is created when these two gases are united in a fiery furnace. When the time comes that ammonia is heated until these two constituent gases separate, they lose the odor, but the ammonia was spoiled by heat, so you see there can be no odorless ammonia, at least for a while. The odor cannot, however, make ice; it has its function, nevertheless, which is to indicate by smell, any small leak.

Another strange thing is that when you dis-associate your ammonia gas by great heat, it increases its volume 100 per cent., and is not condensable. It doubles in volume so it is no wonder the the high pressure climbs upward under such conditions. No one can explain why the volume doubles, we only know it occurs by heating. A good pure ammonia should stand any heat necessary in an ice plant without being spoiled.

Many operating engineers have specified "sulphate made" ammonia and received the ordinary direct distilled ammonia just as many a piece of steel pipe has been sold when iron pipe was specified; all because the user was not careful to see that he got what he specified. If any engineer is alert and smart enough to obtain beneficial efficiency from some particular quality, hard-hearted boss will buy it for him and thank him for being so wide awake. It is the "sleepers" that cannot get what they want from the boss. Do not forget that the wide awake engineer sees more, knows more, explains more and gets more from his employer, in addition to certain added confidence and respect from everybody else. The sleepers get only what is thrown to them—so be a propellor not a drag to your business of making the plant earn money. Keep yourself

*From paper read before the Virginia Manufacturers' Association.

posted by reading your trade journal carefully. If you do not now take a trade journal, then subscribe for one at once, nothing is so disheartening as to find a good man groping about in the dark, surrounded by ignorance and superstition adopting erroneous ideas and guessing at results. Such a man might say "ammonia is ammonia" and believe it all his lifetime.

EXHAUST STEAM ABSORPTION MACHINE EFFICIENCIES*

By B. F. Kubaugh

UNDER this title an attempt will be made to indicate briefly the performance that may be expected of the exhaust steam absorption machine as an isolated distilled water plant; and in various combinations with power or lighting, and compression plants.

In the isolated exhaust steam distilled water plant, we employ auxiliary pumps, either direct steam driven, or engine driven, as required by circumstances. The exhaust from the auxiliaries or engine passes into the ammonia generator under a comparatively low pressure where it is condensed and is afterward skimmed and used in the cans. The quantity of steam condensed by the ammonia generator is more or less fixed, or varies within small limits, and as it is essential that the quantity of steam supplied by the auxiliaries should come within the requirements of the generator, the method of driving them is varied, being direct steam driven for cold water machines, and engine driven for warm water machines.

It has been found that the steam required by the auxiliaries is less, if anything, than that required by the generator, so that it is safely assumed that the total amount of steam required to drive them and to generate the ammonia is represented by the steam consumption of the generator. This varies from 56 to 60 pounds per ton ice per hour, but as 96 pounds of water per hour are required to produce a ton of ice, the difference, or 40 pounds, is made up by a multiple effect evaporator, the condensation from which goes to the distilling system, and the vapor from which is condensed in the ammonia generator together with the pump exhaust. The relation between the quantity of vapor so required, and the condensation, determines the number of effects to be used. This will rarely be less than two effects, nor more than three, for, as stated before, the methods of driving the auxiliaries can be varied so as to require a practically constant amount of vapor from the evaporator.

Evaporator Range of Pressures

The evaporator under this system operates through a wide range of pressures, from the boiler on the initial side to the pump exhaust pressure on the vapor side, and, as it does not require an initial pressure in excess of 100 pounds, can be installed in connection with boiler equipment previously built for this (now) low pressure, thus converting old live steam machines into much more economical exhaust steam types. With this type of machine can be produced 1¼ pounds of ice in the storage room for every pound of steam generated in the boiler, or 25 per cent. more ice than steam. This means that, with a horizontal tubular boiler producing seven pounds of steam per pound of coal, a productios can be obtained of 8¾ tons of ice per ton of coal. With water tube boilers, producing eight pounds of steam per pound of coal, an ice production of 10 to 1 can be obtained. The plant of the Hygienic Ice Co., of Birmingham, Ala., is so equipped and has produced 10½ tons of ice per ton of coal. For small installations where water tube boilers would not be justified, steel encased tubular boilers with shaking grates by their increased economy over the brick-set boiler will increase the production per pound of coal over that given above.

Pure Ice Production

For the production of pure ice free from contact with oil at any stage of the process, the absorption machine occupies a field of its own. In this system, the auxiliaries are of the centrifugal turbine driven type. A plant of this type was installed during the past year for the Crystal Ice Co., Richmond, Va., in collaboration with their manager and chief engineer, J. C. Kent. This plant consists of three 45-ton machines equipped with exhaust steam ammonia generators, replacing live steam generators of the vertical spiral coil type. Part of the old equipment was retained, only that part connected directly with the utilization of exhaust steam being new. The auxiliary equipment consists of one 6-inch and one 8-inch double suction Platt centrifugal water pump, each direct connected to Terry turbines, guaranteed to operate at 77 pounds of steam per horse-power hour with 100 pounds initial and 20 pounds exhaust pressure; one 37½-kw. generator, direct connected through gearing also to a Terry turbine. This generator operates four propellers in two of the three ice tanks; one 8-inch centrifugal pump for circulating in the third ice tank, which could not be equipped with propellers; three 1½-inch centifugal brine circulating pumps; one 6 x 6 Sullivan air compressor for operating the hoists, which it was not desired to chasge. The current consumed for all brine circulation and air compression amounted to only 16 2-3 kw. or about 25 horse-power at the turbine. This, together with the exhaust from the turbines in the water pumps, furnished very nearly enough steam for the ammonia generators. When running at full capacity it was necessary to bleed in some live steam, but when running only one or two of the machines the turbine exhaust and generator consumption just about balanced.

To quote one of Mr. Kent's letters, he says: "Our steam is free from any oil and as pure as can be made. We have not lost a block of ice from oil contamination." He states further that in spite of the handicap of a cool season, allowing full capacity during only one month and running under capacity the balance of the time. "We, however, have made 54½ per cent. more ice per ton of coal this year than last. We cannot see how the most economical engine could have increased our economy."

Combination With Power and Lighting Plants

The combination of the absorption machine with power or lighting plants for the production of distilled water ice has been accomplished with very satisfactory results. The usual method is to operate the ammonia generator with the exhaust from the original auxiliaries to which is added the exhaust from the additional auxiliaries required by the ice plant, such as ammonia pump, brine circulating pump, brine agitator etc., The exhaust from these pumps, more frequently than not, supplies less steam than the generator requires and a small quantity of live steam must be added to make up the deficiency. As the total amount of steam thus utilized in the generator in the production of the necessary refrigeration amounts to only 58 per cent. of the total required for the ice, the remaining 42 per cent. is recovered by means of a condenser from the exhaust of the power or lighting engines at atmospheric pressure. In cases where the power or lighting engines are run only periodically, the steam condensers are made extra large and tanks are provided for obtaining the distilled water when available and holding it in storage to be fed through the cooling and filtering apparatus as required.

Typical Example

Among a number of plants of this kind, mention may be made of a 30-ton ice making equipment installed in the city of Fernandina, Fla., in connection with the municipal light, power and water plant. In this case the water pump supplied the city, having a capacity of two million gallons daily and of course the exhaust from this pump could not be used directly in the ammonia generator, but a portion of it, together with the exhaust from a 100-hp. Ball & Wood and a 150-hp. Skinner electric generating outfit, was condensed in a steam condenser and fed to the cans through the usual skimming, reboiling, cooling and filtering apparatus. Ice is made in this installation at a cost in fuel and labor of only 43 cents per ton and sells at prices ranging from $4.00 per ton in single 300-pound blocks to $6.65 per ton in five-cent pieces. The real or legitimate cost of the ice in this case is considerably under the figure given, which includes the cost of steam really chargeable to the electric light plant. This price also is figured on coal at $3.30 per ton.

*From paper read at the Ky. Mfrs. Association Convention.

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Vol. X. JUNE, 1917 No. 6

PRINCIPAL CONTENTS

Merits of Some Recent Developments in Air Pump Design.....131-133
General 138
Power Plant Operation and Management....Volcanic Steam Power....Smoke Prevention....Refrigerating Plants for Newfoundland.
Power Transmission Section 139-141
Leather Belting....Positive and Friction Clutches....Ball-Bearings in the Woodworking Industry.
General 141
Coke Fuel for Power Stations.
High Pressure Air Compressor Design and Application.....142-146
General 146
Three-Cylinder Compound Electrical Unit.
"Spokes" in Industry's Wheel 147
John Wilkie Taylor.
Electricity and Hydraulics 148-150
Brushes for Commutators and Slip Rings....Electric Hazards....Hydro-Electric Buy Out Ontario Power Co..... Niagara Falls Power Co. Report....Electrical Queries and Replies.
Refrigeration 151-152
Differences in Quality of Ammonia....Exhaust Steam Absorption Machine Efficiencies.
Editorial 153
Proposed Secret Session of British Engineers....Plant Reference Library....The Coming C.A.S.E. Convention and Exhibition—A Suggestion.
The Operators' Viewpoint 154-157
Operating Under Adverse Local Conditions....Factor of Evaporation Chart....Turbine Gear Lubrication....Utilization of Peat as Fuel....How the Moving Picture Film Gets Its Motion....Emergency Repair on Water Pipe....A Draft Kink....Emergency Measuring Methods....Heat Loss in Power Plants....Handy Rule for Finding Content of Cylindrical Tanks.
Question and Answer Section 158-159
Steam Power Plant Auxiliaries 160
Boiler Feed Water Regulators.
Trade Gossip—Catalogues (Advtg. Section) 50-54
Selected Market Quotations 52

PROPOSED SECRET SESSION OF BRITISH ENGINEERS

APROPOS of the recent registration of Canadian engineers, at least those constituting the membership of our various Technical Societies and Associations, with a view to their services being made available to the Government either in consulting, administrative, or research capacities, a unique proposal has been made to secure a secret session of Old Country engineers, at which a representative of the British Admiralty would explain the means being taken to combat the submarine menace, and detail as fully and clearly as possible such problems connected therewith as yet remain unsolved. While it is realized that the Imperial Government can command, and has at its service, no end of what are believed to constitute the best scientific brains available, it is more than probable that much brain wealth is outside the fold. Our British contemporary, "The Engineer," very aptly remarks when discussing the subject that "useful inventions frequently spring from quite unexpected quarters, and that if the brains now officially at work have failed to solve the submarine problem, it is time others were tried, and high time that new fields of thought were explored."

The secret session proposed would be organized and managed by some such body as the Institution of Civil Engineers, the individual members to include men drawn from the country's principal engineering and shipbuilding establishments to the number of say three or four hundred, and of whose ability and integrity there could be no doubt.

PLANT REFERENCE LIBRARY

A FACTOR likely to have considerable bearing upon the increased productive power of manufacturing plants, would be the establishment of a works library, in which a quantity of technical books and other literature would be available for ready reference for those officials who might be confronted with difficult problems pertaining to their particular class of work. These libraries would not require to be stocked with a wide range of subjects, but preferably a quantity of books and periodicals containing a comprehensive record of previous and current practice in the particular lines of activity in which the various plants are engaged.

While the available books would be primarily for reference purposes by the various department heads, the opportunity should be provided for the loaning of these books to any employee desiring same for study. By encouraging the workmen to take a greater interest in the technical features of their daily labors, it would not only increase their productive efficiency but also their earning power; and at the same time provide a means of developing trained men who would take a keener interest in the work they are doing. The returns from a reference library of this nature should more than repay the expense entailed by installation and maintenance.

THE COMING C.A.S.E. CONVENTION AND EXHIBITION—A SUGGESTION

THE generally central location of the City of Toronto from an industrial and manufacturing standpoint leads us to anticipate a record attendance of power plant engineers at the C.A.S.E. Convention and Supplies Exhibition to be held there from July 24 to 27 inclusive. As an excellent "menu" is being provided—business and pleasure, for each day and evening, it has been suggested to us that the local executive in charge of the Convention Souvenir, would, by mailing or placing the latter directly in the hands of all engineers within a reasonable radius, say a week or ten days in advance of the coming function, not only confer a favor on the makers and dealers in supplies and equipment who will exhibit, but eliminate the tendency to indifference more or less apparent in past years to the value of and benefits to be derived by participating in this annual gathering.

The Operators' Point of View

OPERATING UNDER ADVERSE LOCAL CONDITIONS

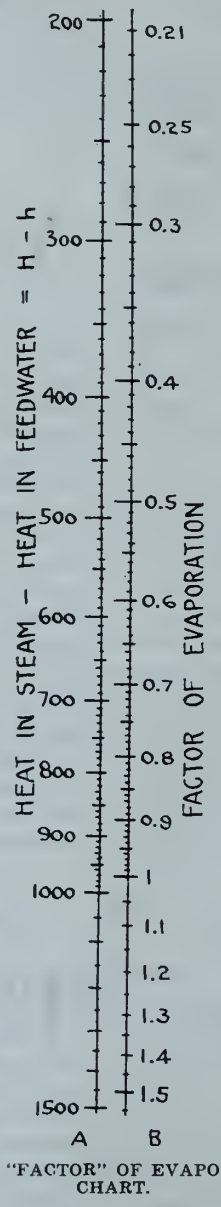
By W. M. Grey.

HAVING had considerable experience in operating power plants, both in the east and west of Canada, perhaps the following would be of some interest to readers:

Taking charge of a plant in the west two years ago, which consisted of gas engines and auxiliaries, of which vacuum pumps and air compressors formed a part, there was some difficulty in keeping a uniform regulation of vacuum and compressed air, which was caused through the high altitude. I might say the altitude at this point is about 2,500 feet above sea level, and variations in atmospheric conditions were noticeable on vacuum gauge and air gauge. This was not a condensing plant, the vacuum being used for the suction of molten glass from a revolving pot at a temperature of about 2,000 degs. F.

The best vacuum obtainable here has been 24.5 to 25 inches, compared with 28 inches in the east for the same manufacturing process, and it naturally makes a big difference in production between plants in the east and west of Canada. The gas engines installed were Bruce McBeth four-cylinder high speed units, belt-connected to two generators, and run on the 24 hours' system. There was also some difficulty in keeping engine jackets cool, the nearest water supply being 2 miles away from the plant, it was necessary to instal water supply tanks with the object of using the same water over and over again in order to get rid of the impurities which consisted of alkali and lime. Owing to the high altitude, and the natural gas in that part of the country, which seemed to develop a high and dry temperature, it seemed utterly impossible to keep cylinders cool, and cylinder heads, which are about the hottest part of the engines, would get steam bound. The only remedy for this at that time was running hot water off the tanks and admitting more cold water to make up the difference. This remedy was all right as far as cooling off was concerned, but only made matters worse in respect to scale conditions. Cylinder heads were taken off the engines after being in service for one month, and the water parts were completely choked off with alkali and lime. Boiler compounds were of no use, as one could not allow the water to get hot enough to enable the compound to do its work. The cooling surface in the cylinder heads being very small, especially in between the gas and exhaust valves where the water passage is only one-half inch wide, this passage would fill up with scale causing unequal expansion and contraction and end up with a cracked cylinder head.

During 20 years' experience in operating gas and steam electro plants this particular plant is one of the best I have ever handled as far as its machinery is concerned, the Bruce MacBeth gas engines are an up to date unit and in my opinion come next to steam engines for steady running, but like all other types of gas engines must have good local conditions in order to obtain good results.



HANDY "FACTOR" OF EVAPORATION CHART.

The object of this article is merely to express our opinion of operative conditions in the east and west of Canada, namely altitude and impurities in water. No doubt some local conditions can be overcome by going to some considerable expense which would eventually pay for themselves.

FACTOR OF EVAPORATION CHART

By N. G. Near.

THE term "Factor of Evaporation" is used a great deal in engineering — so much the writer thought it worth while to work up a chart on the subject in order that anybody can reduce ordinary heat values directly into factors of evaporation without doing any figuring.

For example, you look into your steam tables and find that the total heat in steam at a given pressure is 1,100 B.t.u. You also find that the feed water originally contained 100 B.t.u. per pound. The difference H-h is therefore equal to 1,000 B.t.u.

Find the 1,000 in column A and directly opposite in column B is the factor of evaporation. You can see that it is very close to 1.03.

The figures above 1,000 in column A, are seldom used. They are used sometimes in connection with feed water heater computations, however, and in order to make the chart more complete, I therefore included them also. Thus, where the difference in heat values might be 300 B.t.u., the factor of evaporation is immediately given as 0.31.

TURBINE GEAR LUBRICATION

By O. C.

WITH the increased use of geared drives there is an increased necessity for minimizing friction, thus reducing the wear and noise and increasing efficiency. The best results so far have been obtained with helical gearing, and the use of this has proved extremely advantageous in the case of turbine drives for marine purposes and for direct current generators. The latest types of double helical gears are, however, those which secure the best results, great accuracy being combined with high efficiency and silent operation. The mounting of all gearing should have extra careful attention, especially as to the support of the pinion in high speed and high power work.

The lubrication of turbine gears is effected by means of special sprays arranged to deliver the oil direct on to the teeth, as to allow such gears to run par-

tially submerged in an oil bath would absorb an appreciable amount of power. The pinions of turbine gears are usually of nickel steel, and the large wheels of cast iron with steel rims. To obtain quiet running, straight-cut rawhide, cambric and paper pinionss are sometimes used; ordinary hydro-carbon oil, however, is most destructive to rawhide pinions, and the fact that rawhide pinions have gained a bad name is entirely due to the use of this lubricant. One of the best compounds for rawhide pinions is as follows:—

Plumbago	15%
Resin oil	55%
Resin	30%

UTILIZATION OF PEAT AS FUEL

By T. J.

UNTIL recently there has been no system in existence for the utilization of peat on a commercial basis; but a new invention, which recently reached the commercial stage, offers a means of supplementing the existing coal supply and in the meantime providing an ideal charcoal for the trenches. The whole trouble with regard to the utilization of peat has arisen from the difficulty of completely separating the moisture from the solids. It was this difficulty that all inventors had failed to overcome. The process here referred to, known as wet carbonizing, solves the problem. It is simple and works almost automatically. The peat is pumped from a bog into a reservoir, then fed into tubes, which are steam-jacketed and heated to such a high temperature that a complete chemical decomposition takes place in the peat, and the tiny cells are completely disintegrated; in other words, the water and peat become two distinct elements. The remaining process consists in pressing the water out and drying the peat powder before making it into briquettes. The briquettes contain a fair percentage of nitrogen, and are of a high calorific value.

HOW THE MOVING PICTURE FILM GETS ITS MOTION

By D. A. Hampson.

A MOTION picture film is a celluloid strip about 1½ ins. wide and hundreds or thousands of feet in length, crowded its whole length with thousands of small negatives, just the same as would be made in a little camera of ¾ in. x 1¼ in. size. There are sixteen of these negatives to a foot of length, and so rapidly have they been "snap-shotted," we will say, that a careful observer can see little if any difference between any of the sixteen in a given foot; it is only when a comparison of negatives quite a distance apart is made that a difference is noticed and one begins to comprehend that a progression is occurring and a scene is being unfolded.

The person who, for the first time observes what slow progress he makes with a scene when looking over a film in his hand, cannot fail to appreciate the rapid rate at which the film must run through the projecting machine in order to reproduce the scene in a life-like manner.

Not a Magic Lantern

Most of us have a general idea that this machine is a sort of glorification of the magic lantern of our youth brought up to date by electricity and mechanical

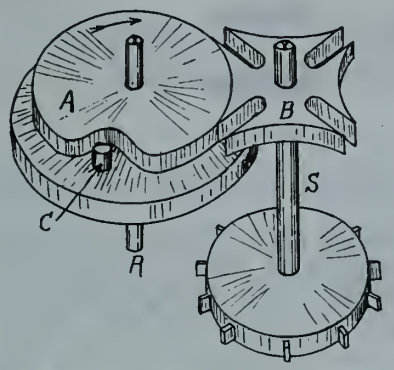


FIG. 1. DETAIL CONSTRUCTION OF GENEVA STOP MECHANISM.

movements so wonderful that it takes a skilled operator to run one. It is very true that if a film is in the machine and is held stationary, a picture from that negative will be thrown upon the screen just as would one from our primitive lantern slide—a noticeable difference being that the film is run through in and up and down direction instead of horizontal. Moreover, in the modern machine the firm travels at a rate that carries about 800 individual negatives per minute through it—a rate so high that without some very ingenious mechanism intervening there would be nothing but a swath of blur moving down the screen. What, then, is this mechanism that rises superior to blur and high speed and countless pictures having no perceptible difference?

What is called a "Geneva" gear is the important part of every projecting ma-

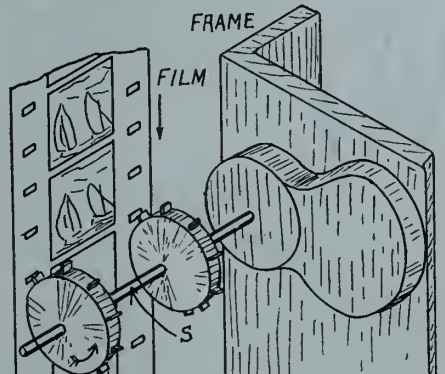


FIG. 2. SHOWING ARRANGEMENT OF GENEVA STOP MECHANISM AND FILM.

chine; it is a motion that (through the aid of other parts) draws the film along, stopping it momentarily when each picture or negative is in front of the lamp only long enough to allow a clear enlargement of it to be thrown on the screen and then, with a jerk that is discernible to the spectator only as a slight flicker, draws it just the height of another negative and brings it to a positive stop. This is done eight hundred times a minute, thirty minutes at a stretch, and always ready for the next roll. This Geneva gear is indeed a triumph, but not a modern one except in its refinements, for in textile mills we find looms bearing a date long "before the war" that are still doing business with the original Geneva in a fair state of preservation.

Action of Geneva Stop

Referring to the drawing, R is a shaft driven at a constant speed all the time, carrying one member of the Geneva gear A, which through the pin C drives a member B on the shaft S, which in turn draws the film through the machine. But while the shaft R revolves four times, the shaft S has made but one revolution and during that one it has been started and stopped four times—this is the motion that is transmitted to the film.

The member A is a disk whose periphery is broken for a short section opposite the pin C, which is rigidly set in the flange of the disk. Concave faces on the member B rest against the periphery of A, and during this period of rest, the shaft S and the film are stationary. Between the concave faces are slots, and as the disk A revolves, the pin C runs into one of them, moving the (so-called) star wheel B a quarter revolution. The movement of B is only possible because of the cut-out section of A opposite the pin. This is the motion that runs so faithfully hour after hour. Of course, the materials have to be of the best, the gears run in oil, and the shafts set for perfect meshing of the parts: in its present perfected state it looks very simple. The gear and shaft ratio is varied on different machines, but the one shown of one to four is generally used.

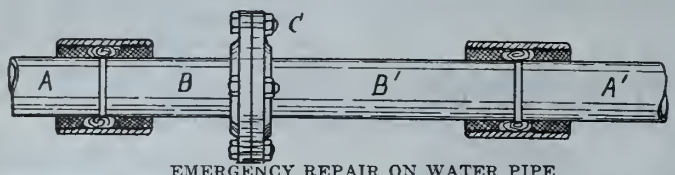
Location of Stop Gear

To make the working of the machine a little more clear, a part of the related mechanism is shown in Fig. 2. Here is shown a portion of the main frame of the entire machine, and also the oil-tight case enclosing the Geneva gear. The same intermittent shaft S extends out from the case and carries on it two sprockets which have a special form of teeth engaging holes in the film. There is a row of these holes of exactly the same spacing on each side of every film made and it is by means of these holes and sprockets that an accurate, positive movement of the film is obtained from the equally positive Geneva gear. This describes the salient features of the motion picture projecting machine of today; there are gears and lenses and lamps and fire shutters, but they are of only passing interest. It might be added that one of the heaviest losses of the films themselves occurs from tearing, which comes from the action of the metal sprocket teeth jerking the light strip of celluloid. A torn film is valueless and though inventors have worked on some other forms of positive drive, they have so far been unsuccessful.

EMERGENCY REPAIR ON WATER PIPE

By John Port

A CAST iron water pipe, 4 in. in diameter, carrying water at 80 pounds pressure, cracked, and a section five feet long



EMERGENCY REPAIR ON WATER PIPE

had to be cut out. There was no cast iron pipe on the job, but a couple of short pieces of 4 in. wrought iron pipe, a 4 in. flange coupling, and two 6 in. pipe couplings were looted out. The two short pieces, of pipe were connected with the flanges C. the couplings were slipped on and back over the ends of the cast pipe ends A.A[1]. Then the 6 in. couplings were drawn back over the pieces B.B[1], after they had been put in place.

Oakum packing was driven into the couplings, as shown by the section, and lead joints run and caulked in the usual way. There is nothing extraordinary in this repair, but it just shows that there is generally some way to overcome a difficulty. In this case lack of cast iron pipe and sleeves did not prevent the man in charge making a proper and permanent repair.

EMERGENCY MEASURING METHODS

By T. Sim.

OFTEN when a man should have a measuring rule with him on some job, he discovers that he has laid it down somewhere and forgotten to take it up again, or perhaps it has fallen out of his pocket. Usually he will "curse" or "bless" his luck, and return to the work-

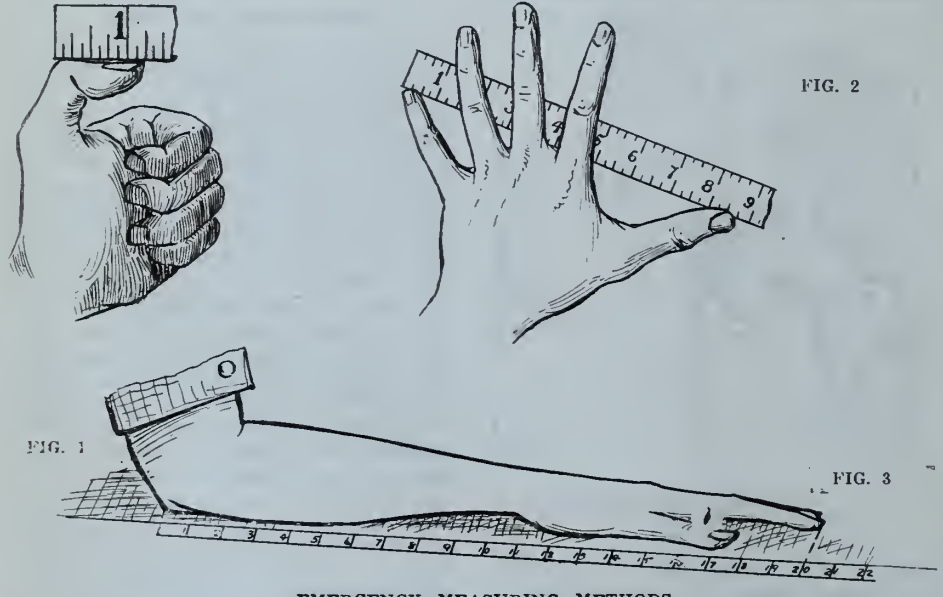


FIG. 1

FIG. 2

FIG. 3

EMERGENCY MEASURING METHODS

shop for a "rule." There are a number of ways for taking measurements with things that are always with us, and other things usually with us. These measurement things will give us approximate measurements only, unless we use considerable care, but if a little trouble is taken to memorize the tips here given, they will often come in handy.

The Dominion $1 and $2 bill is 7 1/16 in. long. An American or Canadian "quarter" is very close to 1 in. in diameter.

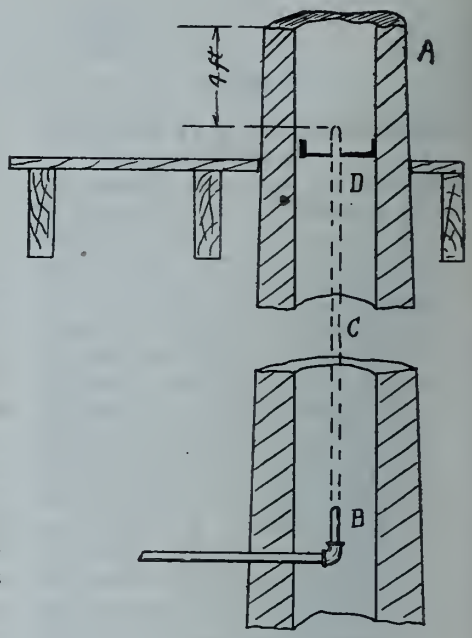
Look at Fig. 1. The upper joint of the averge female thumb is usually very close to one inch. In the average male it is about 1⅛ to 1½ in. The old hand outstretched measure, as shown in Fig. 2, will come close to 8¼ in. in the male. Fig. 3 shows the forearm measure—from the point of the elbow to the tip of the middle finger will be about 20 inches in the adult male and 16 inches in a female. No doubt most readers have seen the store ladies stringing yards of lace or other material, by stretching the material from the chin to the tip of their outstretched hand.

It is a good idea to ascertain the length you take while walking. If you have a knowledge of this, it is an easy matter to figure any distance required by counting your steps. Many men can pace or step off any distance, taking three feet to the step, and come out at the end very nearly correct. A little practice will enable any man to do this with a fair degree of success.

A DRAFT KINK

By John Ellethorn

SOME years ago, the wind blew down part of the stack in a certain building at works where the writer was employed, breaking it off a short distance above the roof. As business was very brisk in this department at the time, orders were given to install a steam jet. The writer did so as shown at B. Fig. 1. This helped some, as the draft showed a decided improvement. However it was still difficult to keep the steam pressure up to the desired figure. As an experiment a length of one inch pipe was attached to the nipple at B, this brought the end of the pipe to within four feet of the top of the broken stack, as shown by the dotted line C. The top end of the one inch pipe was closed in, by heating and hammering, leaving a 3-16 inch hole for the steam to escape. It proved so successful that it was still doing bus-



DRAFT KINK DETAIL

iness when the writer left some months later. A brace, D, held the pipe central in the stack.

No claim is made that this kink will save any fuel or check the smoke. The jet was controlled from a valve, placed handy for the fireman. The quantity of steam the jet will use when discharging into the atmosphere can be found by Napier's rule.

$$W = \frac{pa}{70}$$

Where

W = Weight in pounds per second;

p = Absolute pressure in pounds per square inches;

a = Area of orifice in square inches.

This kink is not recommended as a permanent affair, it is simple and handy in an emergency. A fan will require less steam and give the fireman better control over the fire, but fans have their drawbacks also.

HANDY RULE FOR FINDING CONTENT OF CYLINDRICAL TANKS

By C. T.

THE following table is useful in arriving at the contents of cylindrical tanks placed horizontally, i.e., with the two circular ends standing vertically. The diameter referred to is one passing vertically through the centre of the circu-

lar end. The table can be used for finding how much has been run off (up to one half) if the percentage of the diameter be counted from the top of the diameter. If the measurement along the diameter be made from its bottom end, the quantity remaining in the tank, (up to one half) can be at once found.

HORIZONTAL AND CYLINDRICAL TANKS
CAPACITY IN PER CENT. OF DIAMETER.

1%	of diameter is	0.0017	of capacity.
2%	"	0.0048	"
3%	"	0.0087	"
4%	"	0.0134	"
5%	"	0.0187	"
6%	"	0.0245	"
7%	"	0.0308	"
8%	"	0.0375	"
9%	"	0.0446	"
10%	"	0.0520	"
11%	"	0.0598	"
12%	"	0.0679	"
13%	"	0.0764	"
14%	"	0.0851	"
15%	"	0.0941	"
16%	"	0.1033	"
17%	"	0.1127	"
18%	"	0.1224	"
19%	"	0.1323	"
20%	"	0.1424	"
21%	"	0.1527	"
22%	"	0.1631	"
23%	"	0.1737	"
24%	"	0.1845	"
25%	"	0.1955	"
26%	"	0.2066	"
27%	"	0.2178	"
28%	"	0.2292	"
29%	"	0.2407	"
30%	"	0.2523	"
31%	"	0.2640	"
32%	"	0.2758	"
33%	"	0.2878	"
34%	"	0.2998	"
35%	"	0.3119	"
36%	"	0.3241	"
37%	"	0.3363	"
38%	"	0.3487	"
39%	"	0.3611	"
40%	"	0.3735	"
41%	"	0.3860	"
42%	"	0.3986	"
45%	"	0.4112	"
44%	"	0.4238	"
45%	"	0.4364	"
46%	"	0.4491	"
47%	"	0.4618	"
48%	"	0.4745	"
49%	"	0.4873	"
50%	"	0.5000	"

The value for intermediate percentages may be obtained by interpolation without any serious error.

The table given only extends as far as half the diameter but can readily be extended the whole way by any reader who wishes to use it. For example as-

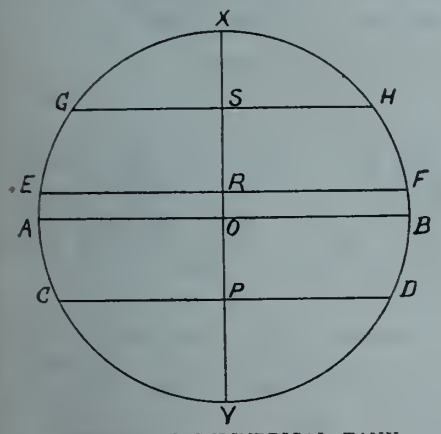


DIAGRAM OF CYLINDRICAL TANK CAPACITIES.

suming that it is being used for estimating the liquid actually in tank, and the percentage of the diameter thus counted starts from the bottom, then 51 per cent. from the bottom is 49 per cent. from the top, subtracting from unity the fraction of the capacity representing the top 49 per cent. viz., 0.4873, 51 per cent., of the diameter is found to represent 0.5127 of the capacity, 52 per cent. is 1—0.4745 or 0.5255 of the capacity, 53 per cent. 1—0.4618 or 0.5382 and so on.

Referring to the diagram which represents one of the circular ends standing vertically, if the surface of the liquid is at AB, then the tank is half full, OY being 50 per cent. of the diameter XY. If it stands at CD the tank contains 0.2523 of its capacity, PY being 30 per cent. of the diameter XY. When more than half full, proceeding as already shown, at EF the tank is 1—0.5382 full as XR is 47 per cent. of the diameters, and at GH it is 1—0.1424 or 0.8576 full, as XS is 20 per cent. of the diameter XY.

HEAT LOSS IN POWER PLANTS

By J. E. Noble.

MUCH has been written, and the half has not been told, about the heat loss in power plants. The B.t.u's wasted at present are a national economic question or ought to be, and too much can not be done towards reducing this loss.

One way of helping towards this end is to keep before engineers and owners the subject in its different phases. Bad furnace and chimney design and shafting out of line mean large losses in dry chimney gas and preventable friction. Radiation from uncovered steam pipes and defective brick work is another source of serious loss in heat units.

A Remediable Loss

One of the greatest losses, however, can be credited to poorly paid firemen who are liable to show the human side of nature by the careless "don't-care-a-curse" style of work done by this class of men; of course, there are exceptions. One of the greatest mistakes made by many otherwise competent business men is to get the cheapest labor possible for the fire-room.

Another great source of waste is heat in exhaust steam, and disregard of the stream of condensation running to the sewer. It is stated that in the average power plant the sensible heat loss in dry chimney gas will go as high as 20 per cent. of the total heat in the fuel. The use of fuel economizers, properly installed and attended to, will reduce this loss by from 25 to 50 per cent. in many plants.

Use of Economizers

The use of economizers will lower the temperature of the chimney gases and utilize the heat which formerly escaped to the atmosphere. The gas temperature in the stack should not exceed 500 degrees, less might do. Attention should be given to the brick work around the boilers, all cracks should be closed up, and soot and scale should be kept out of the boilers as much as possible. The use of a CO_2 recorder is recommended, for, while 15 to 18 pounds of air is required to burn one pound of coal, in many plants 25 pounds or more is used, being more than 50 per cent. in excess of that required. Much of this excess air is due to poor firing, air entering through holes in the fire, while some of it may enter through cracks in the boiler setting and open holes around blow-off pipes, etc.

Some of these obvious improvements have yet to be made in the plant where the writer is employed, but so far as loss due to exhaust steam or condensation is concerned, present conditions are much more satisfactory. We use the exhaust from steam engines, steam pumps, kitchen and laundry equipment, vapor baths, etc., etc. The steam from all machines using cylinder oil is first passed through oil separators, but as the separator is yet to be made that will continually remove all the oil from exhaust steam, the condensation is passed through a filtering heater after the heat of the steam is extracted for heating water and warming buildings and other work.

The drips from the separators are run to oil traps and the oil collected and filtered and used on heavy shaft bearings, as no oil once used should be used in high pressure cylinders a second time.

The Human Factor

However, to obtain efficiency in the power plant, it is necessary to spend a little cash in connection with the comfort and remuneration on the men who do the work. A great deal is written about conserving material, etc.—it is just as important to conserve the power in the workman. Shifts of 12 hours and over are common; wash basins, baths and other toilet fixtures are usually not to be found in the average plant; as a rule the fire-room is cheerless, the work dirty and the pay small, and the conditions about as bad as the health inspector will pass.

And still the owner allows such conditions to exist, and does not consider that he is selfish or unfeeling. Many large plant owners recognize the fact that the poorly paid, poorly looked after fire-room help is a mighty poor investment. Such help can, and often do, waste the amount of their wages several times over, when, if a little consideration was shown them (towards their comfort and welfare), the cost of the investment would be returned several hundred per cent., by causing an interest in the work, and a desire to do the right thing to the employer who did the right thing by them.

Seventeen men were waiting in line at a ticket window in a railway station when an excessively inebriated person thrust himself at the head of the line and shoved thirty-five cents before the ticket agent.

"Gimme ticket f' New York," he said.

"You can't go to New York on thirty-five cents," answered the agent.

The exhilarated man wavered a moment, and then was struck with a brilliant idea.

"Say," he asked, "where can I go for thirty-five cents?"

And seventeen men told him.

Question and Answer Section

Question.—Please give the ingredients and their proportion in some easily prepared freezing mixtures.—T. S.

Answer.—Using finely crushed or grated ice in place of snow, the following are simple mixtures.—Snow 1; common salt 1, reduces from + 32 to 0 deg.; snow 3; hydrochloric acid 5; from + 32 to — 27 deg.; snow 8; calcium chloride 5; from + 32 to — 40 deg. Mixtures without snow are,—ammonia chloride 5; potassium nitrate 5; sodium sulphate 8; water 16, from + 50 to + 4 deg.; ammonia nitrate 1; sodium carbonate 1; water 1, from + 50 to — 7 deg.; sodium sulphate 5; dilute sulphuric acid 4, from + 50 to + 3 deg.

* * *

Question.—(1). What is the best way to connect up three 100 horse-power locomotive type boilers to a main steam pipe or header. The outlet from each boiler is on the side of the dome, and a 4 in. pipe with two bends connects it to the main. A stop valve is located between the bends (see Fig. 1,) the dimensions being as given thereon. Considerable trouble is experienced with leaks. Would it not be better to have connection enter directly into tee-piece or header in vertical position rather than have bent pipe as shown, although the bent pipe may help some in allowing for expansion?

Would not a much smaller pipe than 10 in. be ample for the main?—F.C.

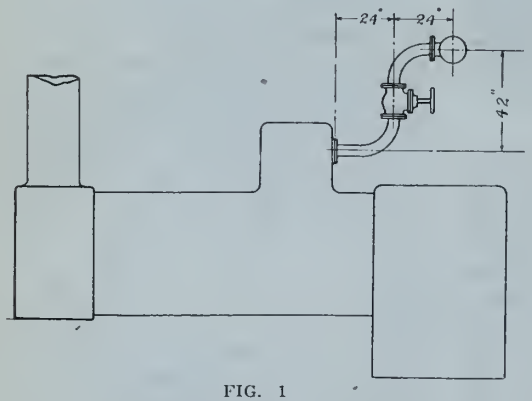


FIG. 1

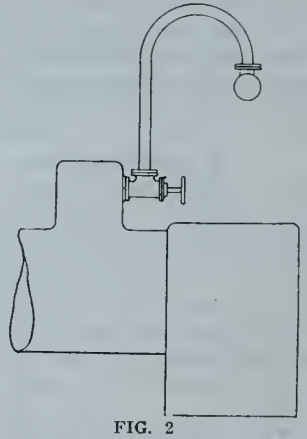


FIG. 2

STEAM HEADER CONNECTIONS TO BATTERY OF BOILERS.

Answer.—The placing of the valve in the centre of a reverse bend as formed by the 4 in. connecting pipe in Fig. 1 is decidedly bad practice. If these pipes are uncovered and a boiler is occasionally shut off, the necessity for making allowance for expansion will be very great; also if the main steam pipe is held rigidly in place there will be considerable strain set up in the connecting pipes when the plant shuts down over week ends, etc. All of this strain will come chiefly on the joints of the valve, and in lesser degree on the end joints. It is not desirable to connect up boilers to the lower side of a steam main. Should any one boiler develop priming and send a volume of water along the main, it will fill up any connecting pipes which may not be in use and cause hammering when they are cut in, while it will also give trouble when it comes to any other connecting pipe which is supplying steam.

The manner of connection shown in Fig. 2 will put the least strain on the valve body due to the longer arm of the bend, and keeps all joints away from the stressed part of the bend. If it is desired to use the existing stop valves, the angle valve shown could be replaced by a cast steel elbow or close bend, and the valve placed on top of that.

None of these arrangements overcome the objection to the steam main being higher than the boiler stop valves, and provision should be made for draining the condensation which gathers in the side of the bend when a boiler is shut off.

The existing size of main steam pipe. 10 in. is in excess of that necessary for three 4 in. pipes. The square of the diameter of the main should be equal to the sum of the square of diameter of connecting pipes. Thus $4 \times 4 = 16$. $16 \times 3 = 48$ = sum of square. $10 \times 10 = 100$ = square of main, which is twice the required size. The square root of 48 is say 7 which is the required diameter in inches of main steam pipe.

Question.—What is the proper method for determining the mechanical efficiency of an engine.—P.L.

Answer.—The mechanical efficiency of an engine is represented by the ratio of the brake-horse-power to the indicated-horse-power, or in other words the proportion of the useful work obtained to the total power imparted to the engine. Stated mathematically.

$$\text{Mechanical efficiency} = \frac{\text{B.H.P.}}{\text{I.H.P.}}$$

If, for example, indicator cards showed that an engine was developing 80 horse-power and brake tests showed 57 horse-power the mechanical efficiency would be 57-80 ths. or 71 per cent.

* * *

Question.—Please give a simple method of determining approximately the thickness of a boiler shell for any desired pressure.—M.L.

Answer.—It is presumed that the greatest safe working pressure is required. In order to determine this, three other factors must be known as follows.

Let P=Greatest safe working pressure.
D=Internal diameter of boiler in inches.
T=Thickness of plate.
f=Safe working tensile stress per sq. in. of metal.

$$P \times D = 2\,T \times f =$$

$$P = \frac{2\,T \times f}{D}$$

By substituting actual values, the result is easily calculated: thus if the plate be ½ in. thick, boiler dia. 60 in., and safe stress allowed 10,000 lbs. per sq. in.

$$P = \frac{2 \times \frac{1}{2} \times 10{,}000}{60} = 166 \text{ lbs. per sq. in. pressure.}$$

Deductions would be made from this in actual practice according to the type of joints employed, workmanship, etc. Various insurance companies have also special formulae which vary according to their individual requirements.

* * *

Question.—How many different sizes of condenser tubes are used in practice, are there any special reasons for making them as small as is usual, and could not steel be used instead of brass for the material?—H.R.

Answer.—The sizes of condenser tubes most frequently in use are five-eighths of an inch and three-quarters of an inch. These sizes are a sort of compromise and have been arrived at as the result

of many years experience of numerous builders. The function of the circulating water which passes through the tubes is to abstract the heat from the steam, and to do this efficiently all of the water which leaves the condenser should, as far as possible have attained the maximum temperature of discharge allowed. If large tubes were used, the tendency of the water would be to drag slowly along the tube surface while the cooler core of the water was forced through at a higher speed, taking less heat with it. and consequently doing less work than if smaller tubes were used and all of the water allowed to receive the heat. The question of packing the tubes also had some influence on their size, as smaller tubes give more trouble in packing! due to their increased number, while their smaller size makes them unsuited to rough handling which occasionally occurs.

Steel condensed tubes are never used because of the corrosion which takes place especially with salt water. The heat conductivity of steel tubes would also be much less than brass or special composition tubes. The galvanic action due to the brass and iron construction has a distructive effect on the tubes, but allowing for this, the superiority of brass over steel as a material for tubes is never questioned.

* * *

Question.—Why is mercury used almost exclusively in thermometers? Are there any reasons in thermometer manufacture which prevent the use of other liquids such as alcohol?—R. T.

Answer.—The principal reasons why mercury is used in preference to alcohol are that its rate of expansion is nearly uniform and the range of temperature between its freezing and boiling points being great enough to cover all ordinary requirements. The high limit of mercury thermometers is raised by filling the space above the mercury with nitrogen gas which is compressed as the mercury rises and raises the boiling points accordingly. Alcohol is used when low temperatures are to be measured owing to its resistance to freezing.

* * *

Question.—How many tons would it be safe to hang from a ¾ in. eye bolt? —N. H.

Answer.—It depends altogether on the nature of the load. If it is simply to hold a heavy object which would be a steady dead load, the permissible weight might be four times that allowed where the load was on chain blocks on some other condition where it would be subject to shock. An average strength for a common steel eye bolt would be 60,000 breaking stress. The area of a ¾ in. bolt at the root of the thread is .302 sq. in., and 60,000 × .302 = 18,120 lbs. load which it might and might not sustain, that is roughly 9 tons. If used for suspending live loads such as occur when hoisting etc., and where the load may jolt or even drop a short distance, one-tenth of the breaking load would be quite sufficient to allow so that 1,800 lbs. or less than one ton would be the permissible load.

Question.—What is meant by "Creep" in a belt. Is there any way of avoiding it?—T.K.

Answer.—Creep is the term applied to the action of belting in motion whereby it changes its position in relation to the pulleys. It is distinct from and must not be confused with "slip". It is proportional to the elasticity of the belt and varies to some extent with the load. When any one portion of a belt is on the slack side, and is approaching the driven pulley, it is under the least tension and does no work beyond sustaining its own weight. As it passes around the surface of the driven pulley, it gradually assumes the stress due to the load and stretches accordingly. It remains in the stretched condition till it reaches the driving pulley when it gradually assumes its former length as it reaches the point where it leaves. The amount of this back and forth movement on each pulley is roughly 1 per cent. of the length of the belt, so that the total loss of velocity is 2 per cent., and must be allowed for in all belting installations where accurate speeds are required. The trouble, of course, can be avoided by the use of chain belts, if circumstances render this form of transmission desirable.

* * *

Question.—What is the function of a dynamo, and of what does it consist?—C. F.

Answer.—Dynamos are mechanical appliances for converting magnetic forces into electrical energy. They are used for the generation of electrical current for lighting and power services. The principal parts of a dynamo consist of field magnets and cores, with their coils, yoke piece, armature, and commutator; brushes with their necessary fittings; the whole being mounted on a bedplate. Rotative motion of the armature is procured by belt, or direct drive from engine or other prime mover. The supply of magnetic force is maintained by the winding of numerous insulated coils of copper wire around the field magnet cores. These coils may be either part of the main lead from and to the dynamo, in which case the magnets are said to be "series" wound; or a wire may be taken from the main lead at the positive brush, wound round the magnet cores and returned to the negative brush; the magnets are then said to be "shunt" wound. Again, when the shunt and the main leads are both taken round the field magnets, the wiring is then known as "compound" wound. The various elements of the armature, as well as the armature and commutator themselves, must be insulated one from another, and from the shaft to which they are attached. The brushes are attached to a rocking frame to secure the desired contact with the commutator.

* * *

Question.—In what respect does an electric motor differ from a dynamo?—M. E.

Answer.—An electric motor when properly constructed differs in no respect from a dynamo, embodying as it does neither more nor less than a direct reversal of the method of action of the dynamo.

* * *

Question.—Describe a method for drying out an induction motor?—G. E. R.

Answer.—There are several methods for drying out an induction motor that has become damp or water soaked. Perhaps the best is to run the motor without load at reduced voltage to cause it to draw a heavy current for heating without dangerous voltage stress. The current should be from one to two times full load value, which will require from 1-6 to 1-3 full voltage for the average motor (slightly less for 25-cycle motors and perhaps slightly more for 60-cycle low-speed motors). If the rotor is of the wound type, the collector rings should be short-circuited as for normal running. This method will apply heat from the interior of the conductors of both stator and rotor.

* * *

Question.—When two single-phase watthour meters are used to measure the energy input to a two-phase induction motor, will not one meter run backward when the power-factor is less than 50 per cent?—G. E. R.

Answer.—Unlike the power-factor of a three-phase circuit, the power-factor of a two-phase circuit has no influence upon the direction in which the meters revolve. Each meter will run forward when the phase to which it is connected feeds energy to the motor. The only condition under which one meter would reverse and run backward is that the voltage of the circuit be so very badly unbalanced that all the power is taken from one phase of the line and the line voltage of the second phase be less than the counter electromotive-force of the motor, thereby causing a return of energy to the second phase of the line. However, such a badly unbalanced condition would be very unusual.

* * *

Question.—What is the ratio existing between the low-speed and high-speed starting torques of a two-speed induction motor?—G. E. R.

Answer.—Two-speed induction motors do not possess a common ratio between their low-speed and high-speed starting torques. The value of the ratio is a property of the particular design of a two-speed motor, not of two-speed motors as a class. Therefore, a specific design of two-speed motor must be considered and its characteristics must be known. The factors upon which the value of the ratio depends are: (1)—The pitch of the stator windings, i.e., whether the high-speed winding is over half-pitch and the low-speed winding is above full pitch. (2)—The end-ring resistance as compared with the bar resistance of the squirrel cage. 3—Whether the motor is designed for constant torque or torque in proportion to speed. While it is a fact that the torque per ampere at starting is ordinarily about twice as great on the low-speed, the actual delivered torque is usually somewhat greater on the high speed than on the low. However, this condition is sometimes reversed by a change in the type of winding used.

BOILER-FEED REGULATORS

PERHAPS no feature of power plant operation has been rendered more vital by reason of modern developments than that of maintaining a correct water level in steam boilers. Particularly where water tube boilers are in use,

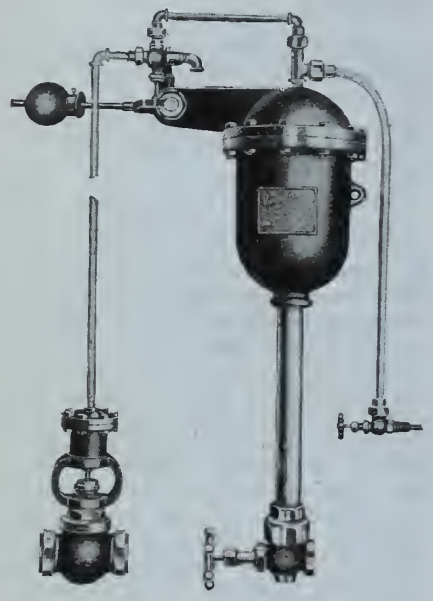


FIG. 1. "VIGILANT" FEED-WATER REGULATOR.

containing a minimum amount of water per square foot of heating surface combined with high rates of evaporation, the necessity of adopting some mechanical device to eliminate the uncertainty of human control becomes more and more evident. In common with other apparatus which has been developed with the object of eliminating the human element, the automatic boiler feed-water regulator, as instanced by the numerous types now in existence, has filled a long felt want successfully, and much of its success has been due to the fact that in addition to fulfiilling primary object of it development its adoption has been accompanied by other benefits such as economy of fuel, the generation of uniformly dry steam, increased life for the boilers, and saving of labor. As a safeguard against explosions due to neglect in hand operations, feed-water regulators are indispensable and for this feature alone if for none other, they should form a part of every boiler equipment.

Economy of Fuel

For every type of boiler there is a certain water level generally, but not always at middle gauge which allows the boiler to work with the maximum heating surface and steam space combined with the safe minimum of water. By operating the boiler constantly at this point maximum economy is obtained. However, in some cases where loads are variable and heavy, the capacity of the boiler may be temporarily increased by allowing it to fill up to the highest desirable level before the heavy load comes on, after which, by reducing the rate of feed, the boiler will steam at an increased rate as the pressure drops slightly. The question therefore arises regarding the advisability of operating at a fixed level or at a variable level, and regulators for each system are available.

Dry Steam

Any properly designed boiler when operated at a proper rating with water of average purity should not prime, but if the water level be allowed to rise too much, and an overload occur at an inopportune moment, the boiler may well earn a bad reputation which should instead be borne by the operator. It is safe to say that probably 80 or 90 per cent. of priming trouble is due to careless handling of the water level. The troubles arising therefrom are familiar to most power house operators,—wasted lubrication with consequent scoring of cylinders, water hammer with its disastrous effects when excessive, and loss of economy even when slight,—all the indirect losses due to the presence of these troubles may be avoided by insuring a safe limit to the variation of water level.

Durability

Boilers are generally allowed to run dry only once, the cost of the trouble is a new boiler, but the effect of a widely changing water level, with its variation in temperature, in decreasing the useful life of the boiler is none the less certain though somewhat slower. Few boilers possess such perfect circulation and steaming capacity that water even at 200 deg. Fahr. can be pumped in at a high rate and then allowed to steam at an increasing temperature, which will again be lowered when feeding re-com-

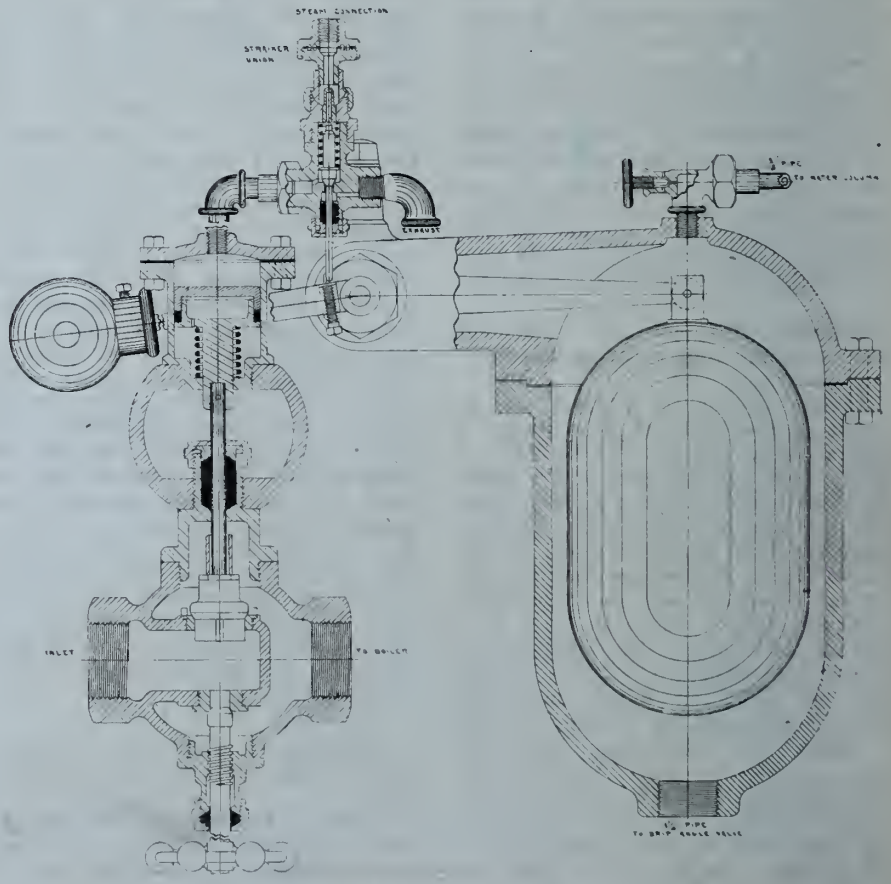
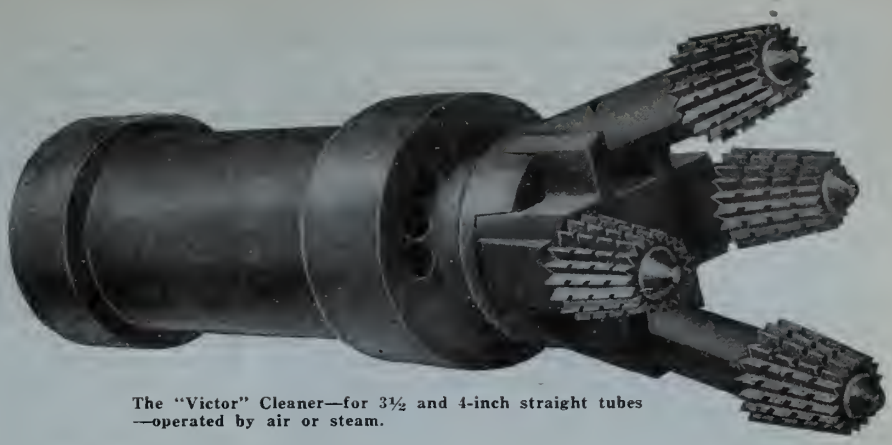


FIG. 2. SECTIONAL VIEW OF "VIGILANT" REGULATOR SHOWING ARRANGEMENT OF OPERATING MECHANISM.



The "Victor" Cleaner—for 3½ and 4-inch straight tubes —operated by air or steam.

THE VICTOR

"The longer it runs the better it works"

This is what Mr. Christensen, Chief Engineer of the Des Moines Electric Company, said when speaking of a test made in his plant between the Liberty "Victor" Tube Cleaner and a "best" cleaner of another make. He had purchased both machines, and the test was simply to find out for his own satisfaction which machine was really the best.

He explained that at the beginning of the test it was about "nip and tuck," but when four or five boilers had been cleaned the other machine began to slow up and they were unable to get very satisfactory results. With the "Victor" Cleaner, he continued, the longer it ran the better work it accomplished.

The results of this test emphasize the claim made for the "Victor" Cleaner—that it will do as much or more work, and will last longer than any other cleaner built. These are the things that count when you have a boiler down for cleaning.

You can't afford to have a boiler idle two days for doing a cleaning job that should be done in one; neither can you afford to have the operator spend a half or more of his time making repairs to the tool.

Whether you have forty boilers with heavy scale, or only one boiler with light scale, you will find it economy in the end to use the best tool available, and for operation with air or steam that tool is the "Victor."

Catalogue "H" describes the "Victor" Cleaner. Also the "Bulldog." It's the one to send for if you are interested in getting rid of scale in the easiest and fastest way.

No scale can withstand the spurs of "Victor" Tube Cleaners.

LIBERTY MANUFACTURING COMPANY

6904 Susquehanna Street **Pittsburgh, Pennsylvania**

The "Bulldog" Cleaner—the King of all Tube Cleaners—operated by water.

mences. Such treatment may not affect a boiler adversely immediately, but the repair bill will be constant and increasing as the years roll on.

Increased efficiency on the part of the attendant is the natural outcome of the adoption of such devices. Just as surely as the safety valve, the high and low water alarm, the fusible plug and the mechanical stoker have relieved him of the strain resulting from continuous attention to numerous duties any one of which in itself may be of a minor nature but when attended to collectively involve a degree of close application which leaves little opportunity and less desire for performing his duties in a loyal and broad-minded manner.

Classification

Feed-water regulators may be divided roughly into two main types—intermittent and continuous—these again being grouped according to the manner of obtaining the motive power necessary for their operation. All regulators, no matter what type consist of two main units, the primary operating device directly affected by change of water level, and the secondary controlling valve on the feed line which is dependent on the primary for its operation. The primary is generally referred to, as the regulator, and the secondary as the controller. While the first type of feed-water regulator has been referred to as intermittent, the majority of them are not really so in the sense of stopping off the feed completely, but are arranged so that minimum flow of feed-water passes through at all times, adjustable to the requirements of any one boiler. As they do not shut off completely, the use of a high and low water alarm is desirable.

The continuous type of feed-water regulator, on the other hand is always in operation except when there is no load on the boiler resulting in maximum water level which stops the controller completely. As the boiler resumes operation, the regulator opens the controller gradually, the amount increasing as the water level decreases till at full load a maximum amount of feed-water is passing while the water level is at the height best suited for full load operation.

"Vigilant" Regulator

This apparatus is of the intermittent type and is actuated by a solid body inside of a vertical column, the weight of the body being altered as it is alternately submerged by the rise and fall of water in the column. By means of suitable mechanism, the movement of the weight is transmitted to the feed valve with resulting control of the feed-water. An exterior view of the entire apparatus is shown in Fig. 1, and a sectional drawing in Fig. 2.

Referring to Fig. 2, a small angle valve on top of the column is connected to the water gauge column at the height at which it is desired to have water level. The lower end of the column is connected to the water space of the boiler at any convenient point. The displacement weight is suspended from one end of a lever whose fulerum shaft extends out through a stuffing box and supports another lever with an adjustable counterweight. The counterweight lever has an adjusting screw set to operate a pilot valve located above, which controls the supply of steam to the operating cylinder of the controlling valve on feed pipe.

The controlling valve is similar in construction to a check valve. A stem extends from the valve to a chamber above the cast iron loop, and is connected to a piston moving in the chamber. The upper cover of the chamber forms a reservoir for water which prevents the live steam from coming in contact with the rubber cup and underneath the piston is a spring to assist in opening the valve when there is no pressure on the piston. In the lower part of the valve body is shown a by-pass or continuous feed valve which can be adjusted to suit any desired rate of boiler consumption and thus minimize the operation of the mechanism.

Assuming the device in operation, as the water in gauge column rises past the opening of the connection to regulator chamber, steam is cut off from the chamber and the contained steam then condenses, allowing the chamber to fill with water through the lower connection. The displacement weight now weighs less than it did when not submerged, and is tilted up by the counterbalance weight which allows the small pilot to seat on its lower end, and open the steam admission valve at its upper end.

The steam pressure immediately depresses the piston of controlling valve and shuts off feed. No more water can enter the boiler until the water returns to the level of the gauge connection when steam again enters the chamber and the contained water returns to its own level. The increased weight of the displacement body causes it to descend, raising the counterweight and reversing the position of the pilot valve. The steam which held the control valve is now exhausted through the lower valve seat and relieves the pressure on top of piston, thus allowing control valve to open again.

The foregoing cycle of operations are repeated as the water gets above or below the desired point, with a variation not exceeding one-half inch. The operation of the device is indicated by the counter-balance weight which is up when feeding and down when shut. This regulator is the product of Chaplin—Fulton Mfg. Co., Pittsurgh.

TRADE GOSSIP

Toronto, Ont.—The William Davies Co. will build an extension to their boiler house on Front Street East at a cost of $6.000.

Toronto, Ont.—The Etobicoke Township Council propose to build an electric light plant to supply current to the district.

Trail, B.C.—The City Council propose spending $80,000 for extensions to the waterworks plant. A by-law will be voted on.

Hespeler, Ont.—A by-law to raise $14,000, to provide for extensions to the waterworks system, has been passed by the ratepayers.

St. Mary's, Ont.—The Town Council will likely expend $1,500 for the purchase of a small motor-driven pump for the pumping plant.

Montreal, Que.—The Howard Smith Paper Mills have under consideration the installation of a 11,000-h.p. hydro-electric unit at Crabtree Mills.

Renfrew, Ont.—The town has purchased the Renfrew Power Co.'s water rights, hydraulic and electrical equipment. The price was $100,000.

Davidson, Sask.—The Town Council propose purchasing a power plant and making improvements to same. The total cost is estimated at $4,300.

Wolseley, Sask.—The Town Council have awarded a contract for a generator and exciter to the Canadian Westinghouse Co., of Hamilton.

Toronto, Ont.—The Standard Chemical Co. have awarded a contract for a 1,500 gallon per minute duplex pump to the Bawden Pump Co., Toronto.

Bala, Ont.—The Bala Electric Light & Power Co. will build a power plant. Grant & Thorpe, of Peterborough, are the general contractors.

Three Rivers, Que.—The City Council are receiving bids on four turbine pumps, each having a capacity of between 2½ and 3 million gallons per day.

Winnipeg, Man.—The Deputy Minister of Public Works has let a contract to the Canadian Westinghouse Co., for motor generator sets, at $28,360.

Niagara Falls, Ont.—The Niagara Falls Power Co. is installing a third generating unit, two having recently been completed and placed in service.

Hamilton, Ont.—The Canadian General Electric Co.'s tender of $1,420 for switchboard extensions has been accepted by the Hamilton Hydro-Electric Commission.

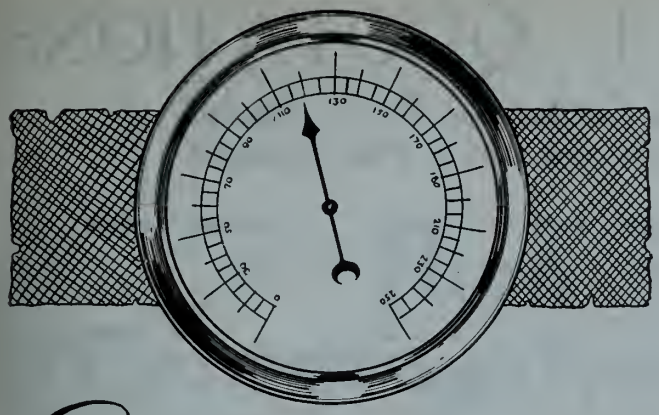
Montreal, Que.—The Montreal Tramways Co. have awarded a contract to the Canadian Westinghouse Co. for a 12,500-k.w. steam turbo-generator for the power station at Hochelaga.

Montreal, Que.—The Frick Ice & Refrigeration Co. have sold a three-ton refrigerating machine to D. D. Drulard, of Windsor, Ont., and another unit to the Montreal Arena, Montreal.

Paris, Ont.—The Town Council are calling tenders for a centrifugal pump with a capacity of 750 gallons per minute. Full particulars may be obtained from G. H. Armstrong, sec.-treasurer.

The International Engineering Works, Amherst, N.S., are building a pair of 25 ins. by 36 ins. centre crank engines for installation at the Armstrong, Whitworth Co. of Canada plant, Longueuil, Que.

Montreal, Que.—The York Manufacturing Co., York, Pa., has sold a 120-ton refrigerating machine and high side to the International Manufacturing Co., Montreal. The plant was installed by the Carrier Engineering Corp., New York.



Can you keep the pointer where it belongs?

It's getting near four o'clock. The demand for power is a trifle heavier than usual. The peak is coming. The sockets click one after another in a steady stream. The demand for steam is going up, up, up. Can You Keep The Pointer Where It Belongs?

Sturtevant
(TRADE-MARK)

Turbo-Undergrate Blower

will keep steam up. It supplies all the draft you want and just when you want it.

When you buy a blower be sure it's a Sturtevant. The Sturtevant name is a guarantee of mechanical excellence—a guarantee that you will have no breakdown and no bearing trouble. The Sturtevant Set has generous bearings with oil rings and large reservoirs. One filling will last for weeks.

To prevent the escape of steam from the casing there is a floating stuffing box. If for any reason through neglect or carelessness this is allowed to leak, there is a special "water-throw" collar which makes it impossible for steam to enter the bearings. Furthermore, the floating stuffing box makes it possible to exhaust against back pressures as high as 25 pounds.

If you have trouble getting enough steam or keeping the needle where it belongs, write us for bulletin No. 214-U.

B. F. STURTEVANT COMPANY OF CANADA, LIMITED
GALT, ONTARIO

Montreal Toronto Winnipeg Vancouver
Selling Agents Sanford Riley Stoker Co., Limited
"THE RILEY STOKER"

Holtwood Plant, Pennsylvania Water & Power Co.,
Waterproofed with R.I.W. Toxement.

Is Your Fireproof Building Waterproof?

In specifying modern Portland Cement construction for your new building, you have minimized the chance of loss by fire. But are you protected against loss by depreciation from water?

At a small additional first cost you can make your fireproof building permanently *waterproof* with

R.I.W. (REMEMBER IT'S WATERPROOF) REG. U.S. PAT. OFF. TOXEMENT PATENTED

This integral waterproofing compound is a dry powder, mixed in small quantities with Portland Cement or clinker. It lubricates the batch of cement, concrete or stucco, and causes the ingredients to knit together in a dense, impenetrable mass.

It does not accelerate or retard the setting, and its use results in a construction that is permanently proof against salt or fresh water. Write for descriptive literature, Dept. 59.

TOCH BROTHERS
Technical and Scientific Paint Makers Since 1848
320 Fifth Avenue, New York
Works: New York; London, Eng.; Toronto, Canada

R.I.W.
REMEMBER IT'S WATERPROOF
REG. U.S. PAT. OFF.
STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$30 00	$.....
1¼ in.	33 00	.....
1½ in.	35 00	30 00
1¾ in.	34 00	30 00
2 in.	38 00	30 00
2¼ in.	40 00	35 00
2½ in.	46 00	36 00
3 in.	52 00	42 00
3¼ in.	.....	48 00
3½ in.	62 00	52 00
4 in.	70 00	65 00

Prices per 100 feet, Montreal and Toronto

BOILER PLATES.

	Montreal	Toronto
Plates, ¼ to ½	$10 00	$10 00
Heads	10 30	10 30
Tank plates, 3-16 in.	10 10	10 10

WROUGHT PIPE

Effective May 14, 1917

Size	Black	Galvanized
	Per 100 feet	
Standard Buttweld		
⅛ in.	$ 4 50	$ 6 00
¼ in.	4 96	7 00
⅜ in.	4 96	7 00
½ in.	6 29	7 86
¾ in.	7 94	10 06
1 in.	11 73	14 88
1¼ in.	15 87	20 13
1½ in.	18 98	24 06
2 in	25 53	32 38
2½ in.	40 95	51 77
3 in.	53 55	67 70
3½ in.	66 24	83 26
4 in.	78 48	98 65
Standard Lapweld		
2 in.	28 49	34 97
2½ in.	42 71	52 94
3 in.	65 85	69 23
3½ in.	68 08	86 02
4 in.	80 66	101 90
4½ in.	93 98	118 70
5 in.	109 50	138 40
6 in.	142 10	179 50
7 in.	185 60	232 05
8 L in.	195 00	243 75
8 in.	224 60	280 80
9 in.	269 10	336 38
10 L in.	249 60	312 00
10 in.	321 40	401 70

WROUGHT NIPPLES.

4" and under, 60%.

4½" and larger, 55%.

4" and under, running thread, 40%.

Standard couplings, 4" and under, 50%.

4½" and larger, 30%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 10%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 45; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill	list plus 40%
At warehouse	list plus 50%

Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	5 00
Steel bars, base, Toronto	5 25
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	5 00
Steel bars, base, Montreal	5 25
Reinforcing bars, base	5 25

SHEETS.

	Montreal	Toronto
Sheets, Black, No. 28	$10 00	$10 00
Sheets, Black, No. 10	9 50	9 50
Canada plates, dull, 52 sheets	8 50	8 50
Canada plates, all bright	9 50	9 50
Apolo brand, 10¾ oz. galvanized	9 75	9 75
Queen's Head, 28 B. W. G.	10 75	10 75
Fleur-de-Lis, 28 B.W. G.	10 75	10 75
Gorbal's Best, No. 28	10 25	10 25
Colborne Crown, No. 28	10 00	10 00
Premier, No. 28 U.S.	9 90	9 70
Premier, 10¾ oz.	10 20	10 00

PROOF COIL CHAIN

B

¼ in.	$10 75
5-16 in.	10 40
⅜ in.	10 25
7-16 in.	10 00
½ in.	9 90
9-16 in.	9 90
⅝ in.	9 75
¾ in.	9 50
⅞ in.	9 40
1 inch	9 25
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	55
Kearney & Foot, Arcade	55
J. Barton Smith, Eagle	55
McClelland, Globe	55
Whitman & Barnes	55
Black Diamond	45
Delta Files	40
Nicholson	45
Globe	55
Vulcan	55
Disston	55

OILS AND COMPOUNDS

Castor oil, per lb.	35
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal.	26½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	6 15
Lard oil, per gal.	1 45
Union thread cutting oil antiseptic	68
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	11

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 50
Leather in sides	1 35

COAL AND COKE.

Solvay Foundry Coke	$10 90
Connelsville Foundry Coke	....
Steam lump coal	8 50
Best Slack	8 05

Net ton f.o.b. Toronto

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lage screws	25
Stove bolts	55
Plate washers	10
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	add 20
Machine screws, o. and fil. hd., brass	add 25
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hex. blank	add 1 75
Nuts, hex. tapped	add 2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	17½
Boiler rivets, base ¾" and larger	$6 65
Structural rivets, as above	6 55
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS

Solder, strictly	$0 38
Solder, guaranteed	0 41
Babbitt metals	16 to 65
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	4 35
White lead, pure, cwt.	17 50
Red dry lead, 100-lb kegs, per cwt.	13 87
Glue, English	0 38
Tarred slater's paper, roll	0 95
Gasoline, per gal., bulk	0 31½
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	0 69
Linseed oil, raw, single bbls.	1 40
Linseed oil, boiled, single bbls.	1 43
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	9 00
Packing, square braided	0 32
Packing, No. 1 Italian	0 38
Packing, No. 2 Italian	0 30
Lead wool, per lb.	0 15
Pure Manila rope	0 33½
Transmission rope, Manila	0 43½
Drilling cables, Manila	0 38½

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2"	$55 00	$52 00
Plain sheets, 14 oz., 14x28 in., 14x60 in.	52 00	54 00
Copper sheet, tinned, 16x60 in., 14 oz.	47 00	56 00
Copper sheet, planished, 14x60 base	61 00	60 00
Braziers' in sheets, 6x4 base	52 00	55 00
Tubing, seamless	58 00	58 00

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 55
Brass sheets 8" wide, 20 oz.	0 60
Brass tubing, seamless	0 57
Tubing, I.P.S., 1" base	0 54

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	25%

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White	Cents per lb
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	35
Sq. & Hex., Head Cap Screws	30
Rd. & Fil Head Cap Screws	10
Flat ⅞ But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	35
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	30
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts add 40,	10
Cold pressed nuts to 1½ in. add	$4 50
Cold pressed nuts over 1½ in. add	$7 00

METALS

	Montreal	Toronto
Lake copper	$38 50	$37 00
Electro copper	38 50	37 00
Castings, copper	37 50	36 00
Tin	63 50	66 00
Spelter	13 50	12 00
Lead	13 50	14 00
Antimony	26 00	30 00
Aluminum	70 00	68 00

Prices per 100 lbs.

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$18 00	$18 00
Sheets, 3½ lbs. sq. ft.	18 00	18 00
Sheets, 4 to 6 lbs., sq. ft.	17 50	17 50

Cut sheets, ½c per lb. extra.

Cuts sheets to size, 1c per lb. extra.

AGENTS WANTED FOR CANADA

FOR

High Efficiency Centrifugal and Turbine Pumps

Design and Material of Highest Class

PRICES MODERATE

LARGE NUMBERS OF

Special Designs for Special Requirements

PULSOMETER ENGINEERING CO., LTD.

11 Tothill Street, LONDON and Nine Elms Iron Works, READING

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
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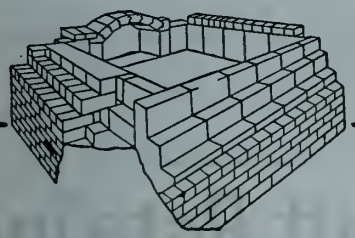
Limited
Sherbrooke Quebec

Engineers, Manufacturers and Erectors of Steel Structures

We Specialize in
Bridges, Buildings, Towers, Tanks, Penstocks, Roof Trusses, Columns, Smoke Flues and Stacks, Coal Bins, Ore Bins, Buckets, Refuse Burners, Stills, Air Receivers, etc.

WRITE FOR PRICES.



Gates Boiler Furnace

Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

—WRITE FOR PARTICULARS—

John W. Gates, 382 St. James St., Montreal, Que.

DIXON'S SOLID Belt Dressing

"Is The Perfect Belt Dressing"

Put up in handy sticks and applied while the belt is in motion.

By using Dixon's Belt Dressing every ounce of "pull" in a belt is quickly made available. Yet the composition of this dressing is such that it will not cause belts to crack or harden.

Better send for a free trial sample now.

Send for booklet 222-O.

Made in JERSEY CITY, N.J., by the
Joseph Dixon Crucible Company
Established 1827
Sole Canadian Agents
CANADIAN ASBESTOS CO., MONTREAL, QUE.

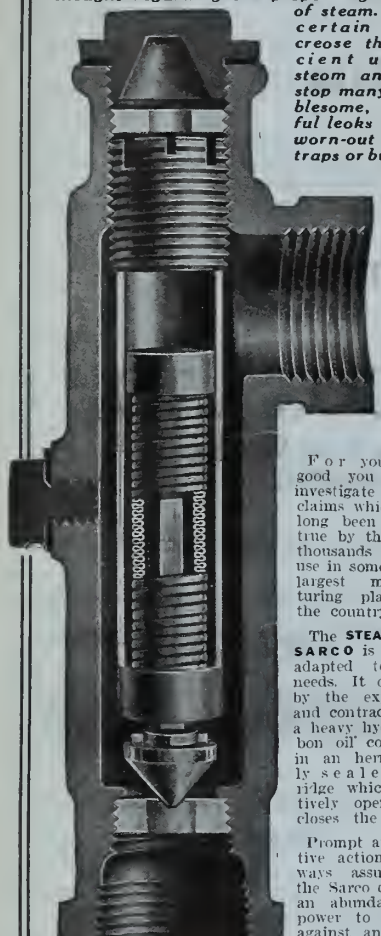
If any advertisement interests you, tear it out now and place with letters to be answered.

AUTOMATIC HYDRAULIC CONTROL

ON EVERY STEAM LINE

STEAM TRAP SARCO

relieves the engineer of oll worry and thought regarding the proper regulations of steam. It is certain to increose the efficient use of steom and will stop many troublesome, wosteful leoks due to worn-out valves, traps or buckets.



For your own good you should investigate our claims which have long been proven true by the many thousands now in use in some of the largest manufacturing plants in the country.

The **STEAM TRAP SARCO** is ideally adapted to your needs. It operates by the expansion and contraction of a heavy hydro-carbon oil contained in an hermetically sealed cartridge which positively opens and closes the valve.

Prompt and positive action is always assured as the Sarco develops an abundance of power to operate against any given pressure up to 2 pounds.

The **STEAM TRAP SARCO** is small, compact and supremely efficient. It may be added to your steam lines as an elbow or bend in the system. The cost is very small and steam lines may be trapped in several places at a smaller cost than with one large old style trap or bucket. By this method of using **STEAM TRAP SARCO** directly at the point of condensation, greater efficiency is secured by the elimination of long stretches of drain pipes to a central controlling trap or bucket.

The **STEAM TRAP SARCO** is the only thermostatic trap capable of positive, accurate operation in high pressure systems. Yet it is equally as practical for low pressure from one to fifty pounds.

You ought to know the Steam Trap Sarco.

30 DAYS' FREE TRIAL

Let us send you an efficient little hydraulically operated **STEAM TRAP SARCO** for 30 days' test. Take it apart. Examine it. Study the simplicity of operation. Find out by practical test what you gain by using it.

Write for Bulletin J—2.

SARCO COMPANY INC.

Woolworth Building New York,

Drexel Bldg., Phila. New Telegraph Bldg., Detroit
Monadnock Block, Chicago Peacok Bros., Montreal

Hamilton, Ont.—The Provincial Board of Health has granted the city's application in regard to waterworks extensions. An expenditure of $127,000 on new pumps at the Beach station is now authorized without reference to the ratepayers.

Swift Current, Sask.—Tenders will be received until June 19, by the City of Swift Current, for one Motor-Driven Centrifugal Pump having a capacity of 800 Imperial gallons per minute against a 300 ft. head. Geo. D. Arnott, City Clerk.

Port Dover, Ont.—A water works system and sewage system are being considered for Port Dover, the approximate cost being put at $65,000. It is likely that a by-law will be submitted to the people in August next.

The **McCord Mfg., Co.,** has been granted an Ontario provincial license to manufacture motors, engines, and machinery of all kinds. The capital is not to exceed $50,000 and the company's attorney is A. R. Bartlet of Windsor, Ont.

Edwin S. Woods & Co., has been incorporated at Ottawa with a capital of $40,000 to manufacture railway supplies, engines, boilers and machinery of all kinds at Montreal. The incorporators are L. A. David, L. P. Grepeau and S. H. R. Bush all of Montreal.

Regina, Sask.—According to information received here, the Federal Governments will expend $300,000 in developing the lignite fields of Saskatchewan at Estevan. The development of those fields will solve the fuel question of this Province, it is believed, and prevent coal famines that have caused so much inconvenience during the past few winters..

A. G. Norris, transmission expert, with the S K F Ball Bearing Co., Hartford, Conn., will spend about three months in Canada on behalf of this concern and in co-operation with the Canadian Fairbanks-Morse Co., who are the sole agents for Canada for the S K F transmissions. Mr. Norris will work on transmissions only and divide his time between the Montreal and Toronto territories.

Hamilton, Ont.—Manager Sifton, of the Hamilton Hydro Commission, has recommended to the Hydro-Electric Board that a $12,000 electric plant be installed upon the premises of the Dominion Steel Foundry. He said that company was now demanding 600 or 700 additional horse-power, and that the installation of a sub-station at that plant would defer the construction of the contemplated sub-station on Trolley Street about two years. The latter would cost $35,000, he declared. The board will consider the proposition.

CATALOGUES

Power Machinery.—MacGovern & Co., New York, have issued a list of used power plant and electrical machinery and contractors equipment, etc.

Vaughan Flow Meter.—A bulletin issued by the Spray Engineering Co., Boston, Mass., illustrating and describing the Vaughan flow meter which is a simple and efficient instrument for indicating the flow of liquids in pipes.

Cooling Water For Ice Plants.—Bulletin dealing with economy cooling circulation water for ammonia or steam condensers by the method of spraying. Issued by the Spray Engineering Co., Boston, Mass.

SKF Ball Bearings.—A pocket list of ball bearings issued by the Canadian SKF Co., Toronto, contains primarily a series of tables giving the dimensions, maximum loads and prices of different sizes of bearings covering all types. Other matter includes illustrations of radial and thrust ball bearings and also a brief description covering the constructional features of the SKF bearings.

Duriron, a non-corrosive metal, is the subject of Bulletin No. 100, recently issued by the Duriron Castings Co., Dayton, Ohio. The bulletin first describes the chemical and physical properties of "Durion," which is of acid, alkali, and rust proof metal. The succeeding pages contain illustrations and descriptive matter covering "Duriron" standard pipe, drainage pipe, fittings, valves, cocks, pumps, blowers, etc. The concluding pages show illustrations of miscellaneous equipment such as tanks, condensers, stills and kettles, etc.

Progress in Water Works Pumps is the title of a catalogue issued by the De Laval Steam Turbine Co., Trenton, N.S., and compiled from the company's records. The catalogue contains a great deal of interesting information relative to development and advantages of steam turbine driven centrifugal pumps for city water supply covering the chief requirements for such installations and the suitability of these pumps for this class of work. An interesting feature of the catalogue consists of a number of brief descriptions of important municipal installations in Canada and the United States, together with half-tones showing the layout of each plant. Copies of this catalogue may be obtained on application from the Turbine Equipment Co., Toronto, Ontario.

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Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box. For any metal.

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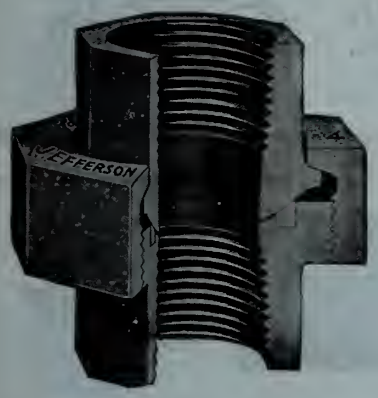

Don't overlook the fact that the brass-to-iron seat makes a corrosionless joint—but different from most unions you will see that here it is set back in a little recess—away from the run-way and pipe contents. The expansion and contraction of the balance of the union cannot loosen it from its embedded position. That's one of the reasons that

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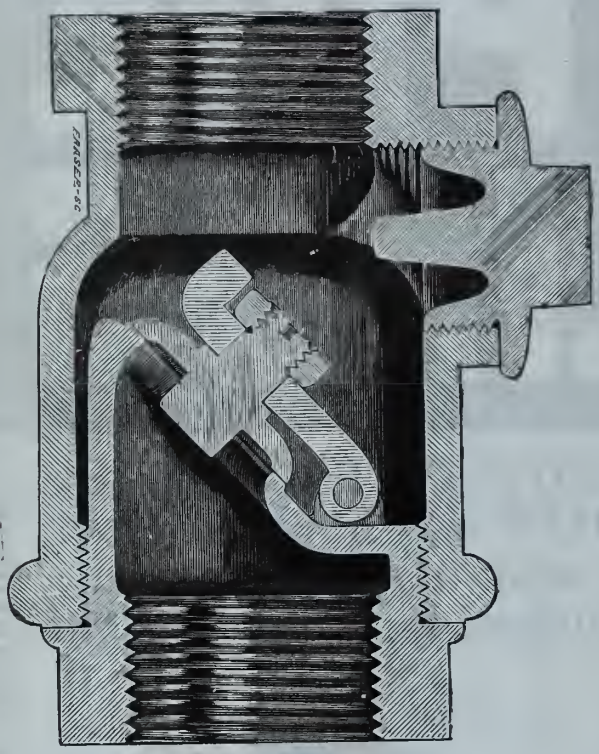

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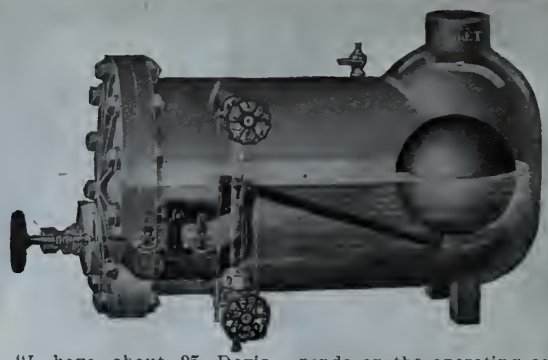

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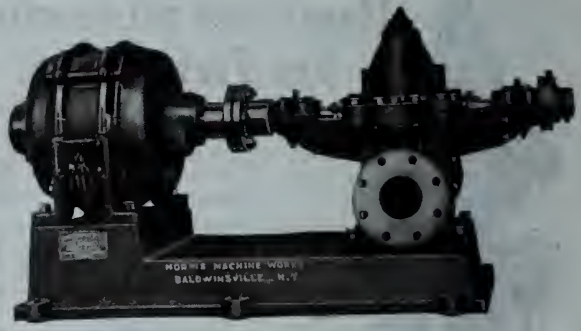

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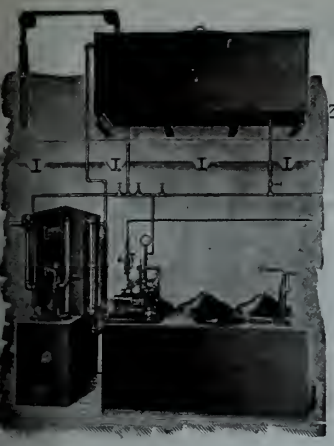

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FOR JULY

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Confederation
the dominant theme of July MACLEAN'S

THE Jubilee of Confederation has led the Editor to make the July MACLEAN'S retrospective and interpretive of Confederation in the character of its main contents—this to meet the certain need and desire of the Canadian people. Note the fine provision of special Confederation article and features:

"THE MEETING OF MACDONALD AND BROWN."
By C. W. Jefferys, a frontispiece painted for MACLEAN'S.

'THE STORY OF CONFEDERATION."
By Thomas Bertram. A colorful narrative of the bringing about of the union of provinces.

"FIFTY YEARS OF BUSINESS EXPANSION."
By W. A. Craick, covering all phases of business—banking, insurance, manufacturing, agriculture, transportation, etc.

"THE BUILDING OF THE C.P.R."
By C. H. Mackintosh, former Lieutenant-Governor of the North West Territories, and an ex-editor of the Ottawa Citizen.

"CONFEDERATION AND AFTERWARDS."
By Agnes C. Laut. An article on Confederation and the taking over of the North West Territories from the Hudson Bay Company.

"SOME CANADIAN CONTRASTS."
By Frank Yeigh. A sketchy article showing some of the most picturesque ways in which Canada has advanced during the last fifteen years.

Look for this symbolic cover design in three colors at book stores and news-stands. It is a fine bit of work, and worth preserving.

"THE DRAFT."
By A. C. Allenson. A story of the part which Canadians took in the American Civil War.

MESSAGES ON CONFEDERATION
appear from the Premiers of many of the Provinces of Canada.

Billy Sunday Contributes:

"WHAT I THINK OF CANADA."
A brief article in the crisp, epigrammatical style of the famous evangelist, illustrated by some of his most recent photographs taken in action in New York.

The Fiction Features:

"THE GUN BRAND."
By James B. Hendryx. An interesting instalment of this exciting serial.

"THE OUTLAW BOAR."
By Clark E. Locke. A short story.

"PUTTING IT OVER."
By Hastings Webling. A golf story.

"THE CAPTAIN OF THE SUSAN DREW."
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They are built to give the utmost service, and are fitted with

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These discs can be replaced in less than a minute, without removing the valve from the line, and without the use of a single tool except a wrench to unscrew the valve bonnet. Bakelite Discs have been proven by many experiments to have the longest life of any disc on the market.

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A Durable Gasket
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Note the Trade-Mark on every gasket.
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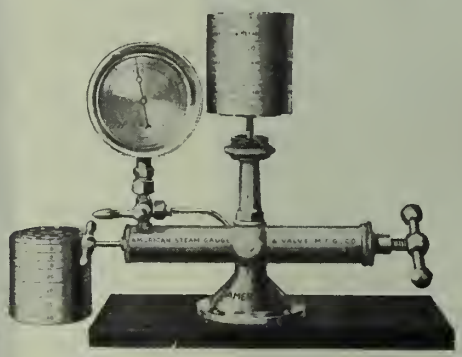

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"PALMETTO"

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Let us send you at our expense a working sample to show how a really self-lubricating packing lasts in service.

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THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

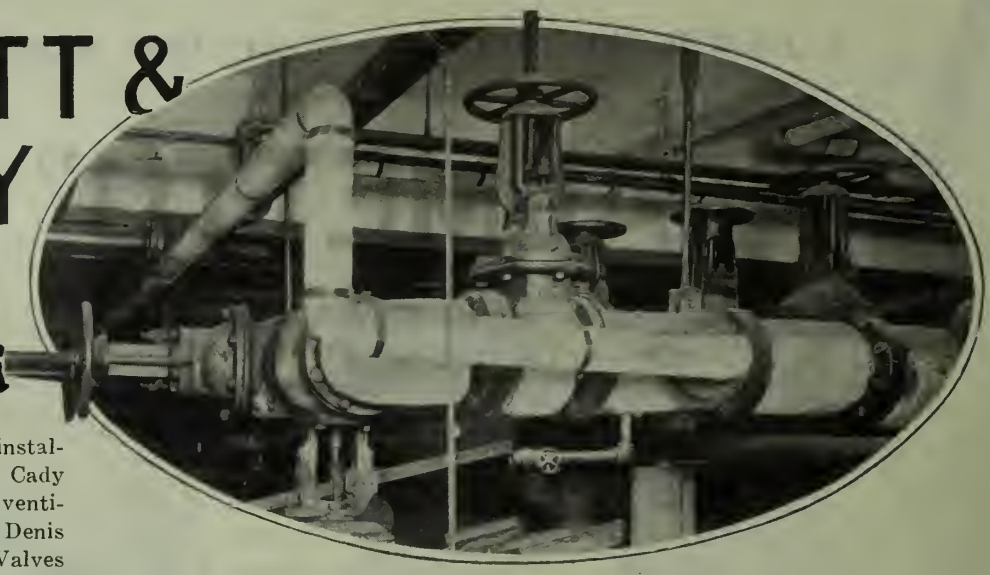
THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

PRATT & CADY

Renewable Seat Ring

Valves



Photograph shows an installation of (6) Pratt & Cady Valves on heating and ventilating system of the St. Denis Theatre, Montreal. Valves range from 10" to 14" Pressure from 80 to 100 lbs. per sq. in.

Pratt & Cady Valves are used extensively—for every service. Their merit has placed them in a class by themselves. Easily operated, take pressure from either side, and will not wedge. Seat Rings are easily renewable without removing the valves from the pipe line.

Our catalog is yours for the asking.

Manufactured by Pratt & Cady, Inc., Hartford, Conn.

CANADIAN SALES AGENTS

The Canadian Fairbanks-Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

It's Safer, Cheaper and More Efficient

Sound and substantial reasons for replacing common straight tube heaters with the—

ALBERGER Multi-Head Heater

DOUBLE FLOATING HEAD

This is a big feature of the "ALBERGER" and eliminates the danger of expansion strains, a serious problem and a menace in other heaters. These floating heads are in sections so as to differentiate between expanding and contracting of tubes of different temperatures.

CUTS DOWN THE COSTS

The Helical Spiral corrugation gives the water a whirl in the ALBERGER HEATER, keeping tubes clean and free from scale. An increase of 50% in heat units is gained over common types of tube heaters thereby. Corrugated Copper Tubes eliminate formation of scale and prevent splitting, common with brass tubes.

Largest of plants are using the "Alberger" exclusively because it is found safer, cheaper, and better in every way. Write for full details.

ALBERGER HEATER COMPANY, BUFFALO, N.Y.

GENERAL SALES AGENTS:

CANADIAN FAIRBANKS-MORSE COMPANY, Limited

St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Windsor, Vancouver, Winnipeg, Victoria.

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

TOOL COMPANY.
COLBURN MACHINE TOOL CO.
2
About a year ago, when we decided to build an addition to our plant, the matter of furnishing power became a serious problem on account of the fact that our power plant was already overloaded and we did not at that time want to install any more power units.
After compiling considerable data we decided to equip our new addition with S.K.F. ball bearing line and countershaft hangers. The self aligning feature of S.K.F. bearings appealed to us as being superior to other makes. We were greatly pleased with the results obtained from this installation, and immediately put in hangers on one of our old line shafts; also countershafts for large grinders and automatic screw machines, with the result that after adding considerable new, heavy machinery, we are experiencing no more trouble with our power plant, having ample capacity to run our shop 21-3/4 hours per day.
The actual saving on a large Landis grinder countershaft is 50%, others running from 20 to 40%, and line shaft from 15 to 25%. These savings were all proven by actual motor tests.
We estimate that the saving in cost of maintenance, and shut downs, due to hot and worn out bearings alone, will pay for the installations in a few years time. Had we not adapted this method of saving power, it would have meant the purchase of an entire new power unit, costing several thousand dollars.
We are replacing all line and countershafts with S.K.F. hangers throughout our plant as rapidly as we can arrange to put them in.
Yours very truly,
COLBURN MACHINE TOOL CO.
Treasurer.
HTB/S Enc.

SKF eliminates shutdown and expense due to hot and worn-out bearings

CANADIAN **SKF** COMPANY, LIMITED

47 KING ST., W. TORONTO, ONT.

Sole Canadian Agents for SKF Transmission Bearings

The CANADIAN FAIRBANKS-MORSE Co., Limited

Branches: St. John Quebec Montreal Ottawa Toronto Hamilton Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

GRATON & KNIGHT

Standardized Series LEATHER BELTING

Tanned by Us for Belting Use

What is Standardized Belting ?

Standardization of Graton & Knight Belts is not new. They have been standardized for many years.

They have been standardized on the basis of the work to be done—not made to meet theoretical specifications, laid out on paper for belt-makers to follow blindly.

During 66 years of actual usage these belts have survived and evolved into recognized, practical standards. And because they have evolved on the job, they have gradually become fitted to each kind of belting job.

There is a brand for every need—a complete and adequate Series of Standardized Belts. Each Brand is uniform as to tannage, strength, weight, performance—and each roll of each Brand.

Standardize the buying of your belting—and learn why it is so easy, so practical, so safe to merely specify "Graton & Knight—or equal."

Write for a description of Graton & Knight Standardized Brands and a copy of their book on belting. Or let them send a representative who will tell you about Belting Standards.

The Graton & Knight Mfg. Company
Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packings and Sundries.

Worcester, Mass., U.S.A.

Canadian Representatives: The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Edmonton, Vancouver, Windsor, Winnipeg, Victoria.

GRATON & KNIGHT

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

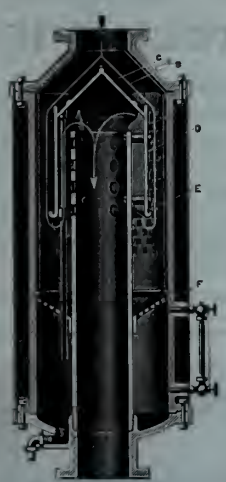
Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

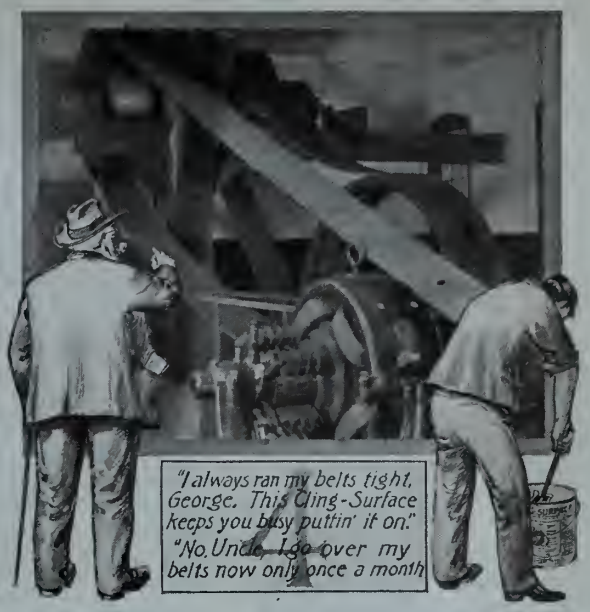
DIRECT SEPARATOR COMPANY

820 Geddes Street - SYRACUSE, N.Y.

General Sales Agents:

Canadian Fairbanks Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria


"I always ran my belts tight, George. This Cling-Surface keeps you busy puttin' it on."
"No, Uncle—I go over my belts now only once a month"

WE stood and watched him.

Above and on all sides of us the belts were moving: large and small, vertical and horizontal, quarter-turn and cross belts; each moving swiftly, silently.

There seemed to be thousands! And the Superintendent had told us that this ONE MAN took care of them all! We stood and watched him.

He carried a pail, and a stick wrapped at one end with a cloth bandage. Dipping this into the pail he carefully wiped the excess off upon the edge and laid the stick against the face of a moving belt. As he worked it back and forth we saw a light stain appearing on the pulley face. He was watching this also, for apparently satisfied, he stopped the treatment and went on to the next belt.

So that was all? A dip, a wipe and a few passes back and forth across the belt face? But how long would it last?

"That belt," said the Superintendent, "is now in such fine condition that it will not require any more CLING-SURFACE for a month. It is quite pliable, waterproof and practically oilproof, and what is more important still, it never slips even under the peak load. You see it is running very slack—we haven't had to take it up for three years.

"Before I had the shop use CLING-SURFACE we ran all our belts tight, and were having trouble every day. It kept four men busy just taking up belts, and applying belt dressings, but now this one man with the new semi-liquid CLING-SURFACE treats them all."

* * *

That is the NEW way to apply the NEW semi-liquid "easy-to-use" CLING-SURFACE. It requires no heating in ordinary temperatures. It results in a money saving more than covering the cost of the CLING-SURFACE required.

The plan 10,000 firms have found successful will interest you. Let us send it free, with any special service your conditions may require.

Remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface Co

1057 Niagara Street
Buffalo New York

If any advertisement interests you, tear it out now and place with letters to be answered.

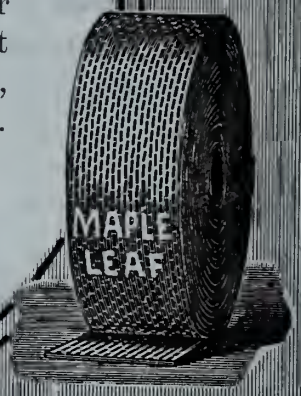
"Maple Leaf" Brand

THE BEST FOR ALL KINDS OF BELTS

Stitched Cotton Duck Belting

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.



Dominion Belting Co., Ltd.,

HAMILTON, CANADA

Goes Right on Your Present Valve Wheel

"Goes on" is about right, too, it's so easy to apply, and by putting a

Babbitt Adjustable Sprocket Rim

on each of those hard-to-get at overhead valves you can save a lot of time you now spend in hunting ladders and all the risk you now run in using them after you've found them. One concern that thought two would do, bought 27 in a little over two months. The price will encourage you to have enough of them.

Ask your dealer. Write for Illustrated Folder.

Babbitt Steam Specialty Co., 59 So. Wate. Street **New Bedford, Mass**

The R. E. Cleaton Co., 20 St. Nicholas St., Montreal, Que.

ROTO TUBE CLEANERS

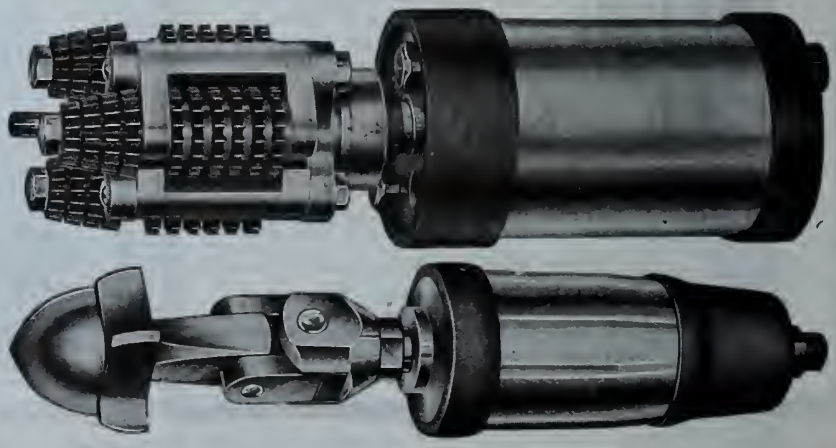
Type A. D.—Driven by Air or Steam
Type W. D.—Driven by Water Pressure

More power from your boilers.
Less coal per power produced.
No burned out boiler tubes.

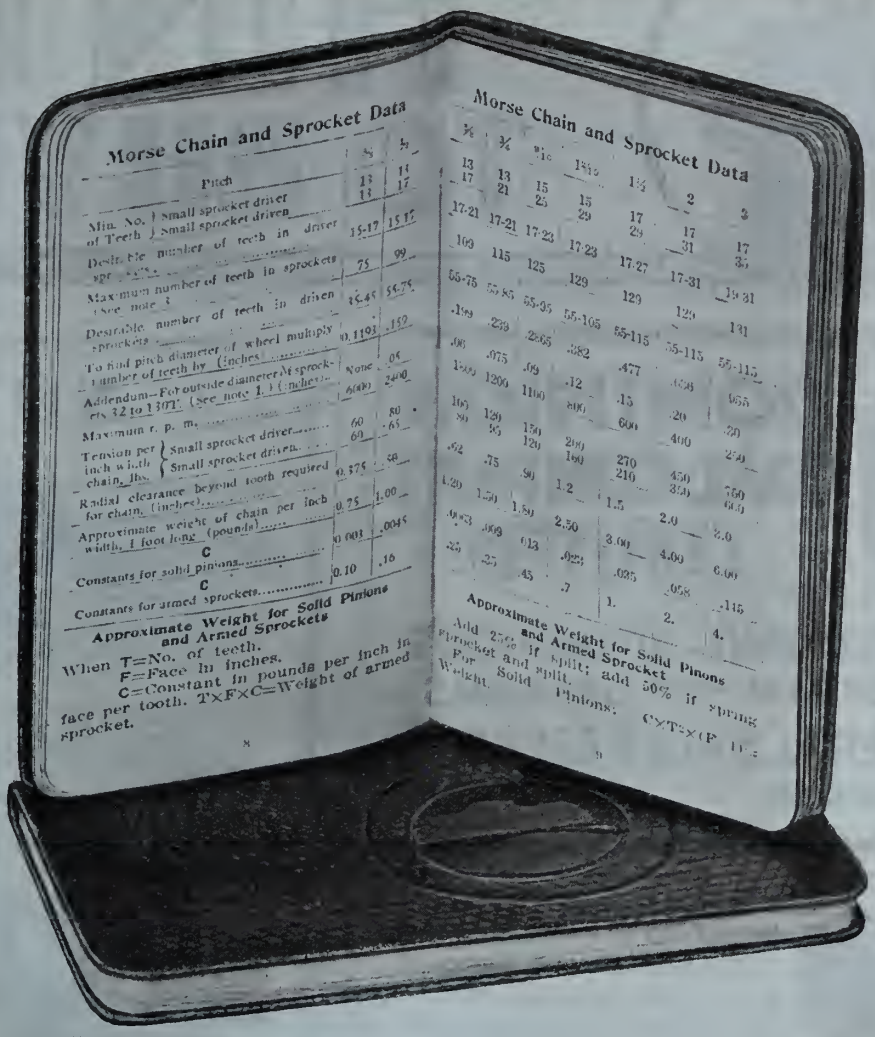
The only cleaners for hardest scale.
Safest and fastest for light scale.
Best for all boiler scale conditions.
Standard of the largest power plants.

THE ROTO COMPANY

Write for Catalog HARTFORD, CONN.



Last Call for the Diary of 1917


Morse Chain and Sprocket Data
Pitch
Min. No. of Teeth
Desirable number of teeth in driver
Maximum number of teeth in sprockets
Desirable number of teeth in driven sprockets
To find pitch diameter of wheel multiply number of teeth by (inches)
Addendum—For outside diameter of sprockets 32 to 130T (See note 1.) (inches)
Maximum r. p. m.
Tension per inch width chain, lbs.
Radial clearance beyond tooth required for chain, (inches)
Approximate weight of chain per inch width, 1 foot long (pounds)
Constants for solid pinions
Constants for armed sprockets
Approximate Weight for Solid Pinions and Armed Sprockets
When T=No. of teeth.
F=Face in inches.
C=Constant in pounds per inch in face per tooth. T×F×C=Weight of armed sprocket.
Morse Chain and Sprocket Data
Approximate Weight for Solid Pinions and Armed Sprocket
Add 25% if sprocket and split; add 50% if spring
For Solid Pinions:

THE Morse Chain Company 1917 Diary is a diary in name only, the memorandum pages not being dated as in previous year. The book therefore does not get out of date as the year draws to a close.

Eighty 2½ by 4¼ plain ruled pages, in addition to 48 pages of MORSE Chain Data and Illustrations, bound in genuine black leather, make a book but ¼ inch thick and just the right size for the vest pocket.

Over 6000 of these little Memo and Data Books have so far this year been distributed to manufacturing plant men in the following positions:

PRESIDENTS	SUPERINTENDENTS	MANAGERS	MINING ENGINEERS
VICE-PRESIDENTS	PURCHASING AGENTS	ELECTRICAL ENGINEERS	AUTOMOBILE ENGINEERS
SECRETARIES	MASTER MECHANICS	MECHANICAL ENGINEERS	

In other words, we have given the book without charge or obligation of any kind to those to whom the data would be of value and who hold positions of authority as regards the purchase of equipment.

Only about 500 of the books are still available, and if you desire a copy we suggest filling out the coupon below and forwarding it to-day—to-morrow may be too late.

Morse Chain Company

ITHACA, N.Y., U.S.A.

Sales Offices in Many Important Cities

Manufacturers of "Rocker-Joint" Silent Chain Power Transmission exclusively.

MORSE CHAIN CO., Ithaca, N.Y. S-29

Please send free copy of your 1917 Vest Pocket Memo and Data Book to:

Name ..... Title.....

Company .....

Street .....

City ..... State.....

Write plainly. P.H. 6-17

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A., PH. D., Superintendent, Trades & Labour Branch.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

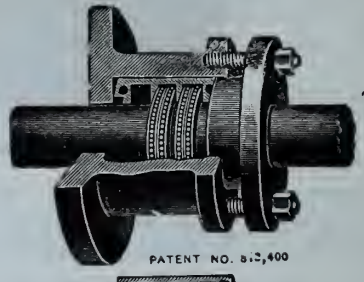
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.

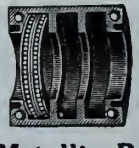
THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



PATENT NO. 8[illegible],400

PAT. NO. 436,177 · " " 800,899 · " " 554,104 · " " 902,328



PAT. NO. 854,841 · " " 854,842 · " " 725,666

Why not Buy the Best, when in market for Packing?

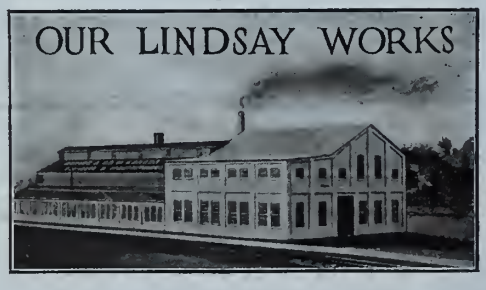
HOLMES' Metallic Packing

is Guaranteed 3 years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

Holmes Metallic Packing Co., Wilkes-Barre, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
LINDSAY, ONTARIO

THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa.

Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

Representatives:
J. M. Allen, 65 Bloor Street West
Toronto, Ont.
Wm. Reid, 27 Celebration St.
St. John N.B.

PLIBRICO — Endorsed by some of the leading Engineers as the GREATEST FURNACE LINING OF RECENT TIMES.

PLIBRICO—makes a solid one-piece lining without joints. Absolutely gas and air-tight. Saves its cost in fuel in a month or two—you will have a steady fire with less effort and less coal by using it.
PLIBRICO—is mixed ready for use, requires only half the time to install and does not require skilled labor. Any laborer who is at all familiar with the building line can use it. DOES NOT BREAK, CRACK OR SHELL OFF LIKE ORDINARY BRICK.
Can be used for front door arches, side walls, brick walls, combustion chamber and rear arches. Sets quickly—after a few hours with a low fire to drain out the moisture, you may fire up as usual. No special forms required.
Ideal for temporary repairs. Better order a barrel and have it ready for an emergency.

PLIBRICO BOND— A HIGH TEMPERATURE CEMENT FOR REPAIRS.

"PLIBRICO BOND" is a product which gives a perfect bond between fire-brick, and does not allow the fire to burn out the joints, as is the case where fire-clay is used. Prevents furnace walls from cracking and crumbling.
It's the most practical and logical high temperature mortar you can use. It's the ever-ready repair cement that you should have in case of emergency.

CANADIAN SALES AGENTS
BEVERIDGE PAPER CO., Limited, Montreal, P.Q.

YOUR MONEY'S WORTH

You are sure of it when you buy a

SMART-TURNER PUMP

The Smart-Turner Machine Co., Limited
HAMILTON, CANADA

More Dollars

You can make "Dollars Grow" out of your *spare time.* Spare-time efforts have made hundreds of dollars for MacLean Representatives. To-day there are in Canada, men and women, who find that our proposition worked for an hour or two daily provides for many of the added luxuries of life. You supply us the time,—we'll supply you the money. Write for full particulars.

The MacLean Publishing Co., Limited
Dept. M, 143-153 University Avenue, Toronto, Can.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.
Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.
Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.
In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

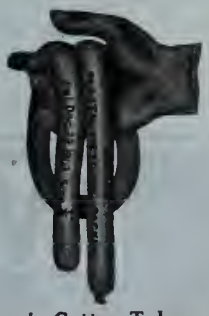
GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

Practically Frictionless

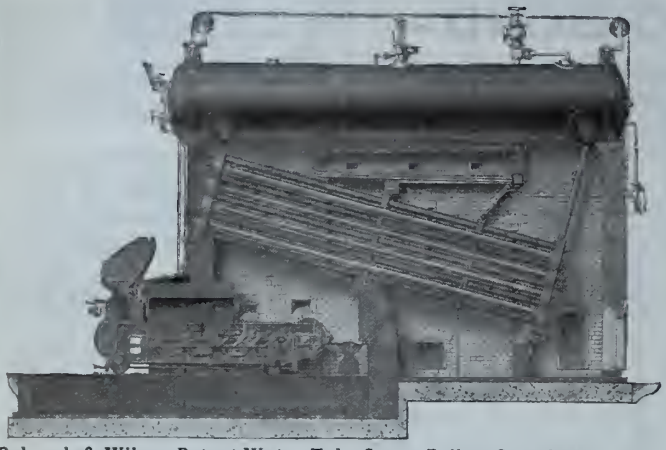


In Cotton Tubes

If any advertisement interests you, tear it out now and place with letters to be answered.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 16,000,000 H.P. IN USE



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

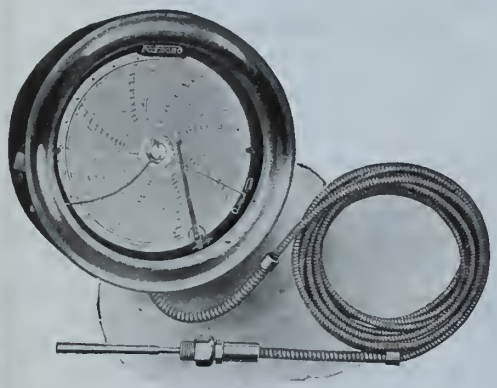
—ALSO—

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

Our Book "STEAM" sent on request

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING



To Get Longer Service From Generators —

Protect them against excess heat under over-loading conditions by applying a

FOXBORO TRADE MARK **RECORDING THERMOMETER**

with Electric Alarm Attachment.

This instrument enables you to watch carefully the temperature effect of high loads, to load your generator to the maximum, to check daily operations and load conditions.
Overheating and possible burning is prevented by alarm attachment.
Drop us a card for Bulletin No. B.H. 96.

Large Stocks carried in Canada by

PEACOCK BROTHERS : : MONTREAL

Manufactured by THE FOXBORO CO., Inc., FOXBORO, MASS., U.S.A.

Advertising makes for a better product—

Not only does advertising create a good impression regarding the product advertised but it **makes for a better product.** There are added responsibility and written-printed claims to substantiate.

WATER SOFTENING OR FILTRATION

FOR BOILER FEED AND ALL INDUSTRIAL USES
WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

THE POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

AIR COCKS
Lunkenheimer Co., Cincinnati, O.
Penbertby Injector Co., Windsor, Ont.

AIR COMPRESSORS AND RECEIVERS
American Steam Pump Co., Battle Creek, Mich.
Beliss & Morcom, Birmingham, Eng.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

AIR RECEIVERS
MacKinnon, Holmes & Co., Sherbrooke, Que.

AIR WASHERS
Spray Engr. Co., Boston, Mass.

AMMETERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.

AMMONIA VALVES AND FITTINGS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

AMMONIA TANKS
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
Canadian Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. B. K. Morton Co., Toronto, Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BABBITT RETAINER
A. S. K. Chemical Co., Elora, Ont.

BALL BEARINGS
Can. S K F Co., Toronto, Ont.
Lyman Tube & Supply Co., Montreal, Que.

BALLCOCKS
D'Este Co., Julian, Boston, Mass.
McAvity & Sons, T., St. John, N.B.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Federal Engineering Co., Toronto, Ont.

BELT CEMENT
Graton & Knight Mfg. Co., Montreal.

BELT DRESSING
Cling Surface Co., Buffalo.
Jos. Dixon Crucible Co., Jersey City.
C. C. Snowdon, Calgary.
Dominion Belting Co., Hamilton, Ont.
Federal Engineering Co., Toronto, Ont.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
American Pulley Co., Philadelphia, Pa.
Waterous Engine Works Co., Brantford, Ont.

BELTING, BALATA
Can. B. K. Morton Co., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Lyman Tube & Supply Co., Montreal, Que.
Waterous Engine Works Co., Brantford, Ont.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.
Plewes, E. B., Winnipeg, Man.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. B. K. Morton Co., Toronto, Montreal.
Federal Engineering Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren, Ltd., Montreal.
Plewes, E. B., Winnipeg, Man.
Sadler & Haworth, Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal
Peerless Mfg. Co., New York, N.Y.
Quaker City Rubber Co., Philadelphia.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can Sirocco Co., Windsor, Ont
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Coppus Eng. & Equip. Co., Worcester, Mass.

BOILER COMPOUNDS
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Dearborn Chemical Co. of Canada, Toronto.
C. C. Snowdon, Calgary.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mf.g Co., Woodstock.
Dearborn Chemical Co., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Perolin Co. of Canada, Toronto, Ont.

BOILER FEED PUMPS
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Limited, Hamilton.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Peiler, H. L., Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

BOILER GRAPHITE
Joseph Dixon Crucible Co., Jersey City, N.J.

BOILER MOUNTINGS
Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Peiler, H. L., Montreal.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Canadian Griscom-Russell Co., Ltd., Montreal.
Peiler, H. L., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

BOILER SKIMMERS
National Steam Pump Co., Upper Sandusky, O.

BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg.
Laurie & Lamb, Montreal.
Roto Co., The, Hartford, Conn.
Wm. B. Pierce Co., Buffalo, N.Y.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
Jones Underfeed Stoker Co., Toronto.
John McDougall Caledonian Iron Works, Montreal.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
McAvity, T. & Sons, Ltd., St. John, N.B.
Polson Iron Works, Toronto.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
John McDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford, Ont.

BOOKS
MacLean Publishing Co., Toronto.

BRASS FOUNDERS
McAvity, T. & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BURNERS, ARGAND
Precision Instrument Co., Detroit, Mich.

CALORIMETERS
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CAST IRON FITTINGS
Lunkenheimer Co., Cincinnati, O
McAvity, T. & Sons, Ltd., St. John, N.B.

CASTINGS, BRASS AND IRON
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Lunkenheimer Co., Cincinnati, O.
John McDougall Caledonian Iron Works Co., Ltd., Montreal.
McAvity, T. & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

CHAIN DRIVES
Morse Chain Co., Ithaca, N.Y.

CHAIN HOISTS
Lyman Tube & Supply Co., Montreal, Que.

CHAIN WHEELS
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, STEEL
Babcock & Wilcox, Ltd., Montreal.

CHEMICALS
Dearborn Chemical Co., Chicago.
C. C. Snowdon, Calgary.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Foxboro Co., The, Foxboro, Mass.

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Waterous Engine Wks., Co., Brantford.

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Dom. Coal Co., Montreal.
Ohio & Michigan Coal Co., Detroit.

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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

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Babcock & Wilcox, Ltd., Montreal.
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Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Tod Co., Ltd., G. H., Toronto, Ont.
Waterous Engine Works Co., Brantford, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

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CONDENSERS
Albeiger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Belliss & Morcom, Birmingbam, Eng.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Wks., Montreal.
Waterons Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
Terry Steam Turbine Co., Hartford, Conn.
York Manufacturing Co., York, Pa.

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Jamison Cold Storage Door Co., Hagerstown, Md.

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Can. H. W. Johns-Manville Co., Toronto, Ont.

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G. M. Davis Regulator Co., Chicago.

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Dart Union Co., Ltd., Toronto, Ont.

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Walter J. Francis, Montreal.
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MacKinnon, Holmes & Co., Sherbrooke, Que.

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Jeffrey Manufacturing Co., Montreal.
Tod Co., Ltd., G. H., Toronto, Ont.
Waterous Engine Works Co., Brantford.

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Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y

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Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

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Mason Regulator Co., Boston, Mass.
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Borden Canadian Co., Toronto.
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York Manufacturing Co., York, Pa.

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York Manufacturing Co., York, Pa.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.

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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

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Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
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Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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Can. Sirocco Co., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
John MacDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford.

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Waterous Engine Works Co., Brantford.

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Hare Engineering Co., Toronto.
Jas Morrison Brass Mfg. Co., Toronto.
Terry Steam Turbine Co., Hartford, Conn.
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Lunkenheimer Co., Cincinnati, O.
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Coppus Engr. & Equip. Co., Worcester, Mass.
B. F. Sturtevant Co., Boston, Mass.

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Babcock & Wilcox, Montreal,
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Canadian Griscom-Russell Co., Ltd., Montreal.
George W. Cole Co., Toronto.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
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Waterous Engine Works Co., Brantford.

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Stewart Heater Co., Buffalo, N.Y.

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Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
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Laurie & Lamb, Montreal.
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John McDougall Caledonian Iron Works, Montreal.

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Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
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Gates, J. W., Montreal, P.Q.

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Jones Underfeed Stoker Co., Toronto.
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Economy Fuse & Mfg. Co. of Canada, Montreal.

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Graton & Knight Mfg. Co., Montreal.
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Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
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S-C Regulator Co., Fostoria, Ohio.
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Lunkenheimer Co., Cincinnati, O.
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

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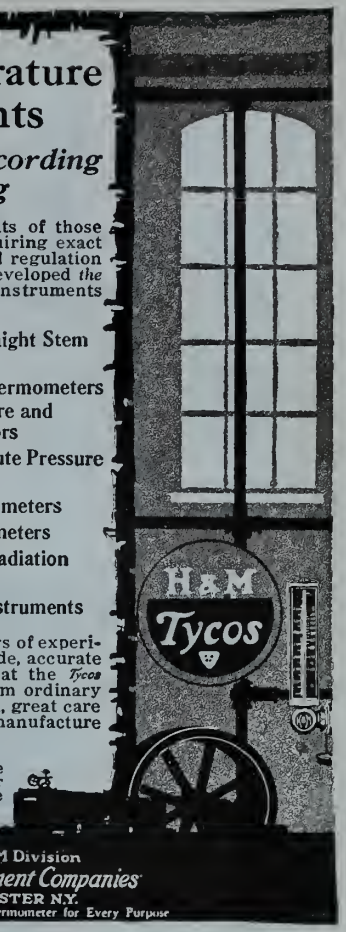

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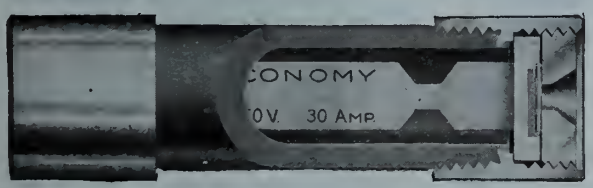

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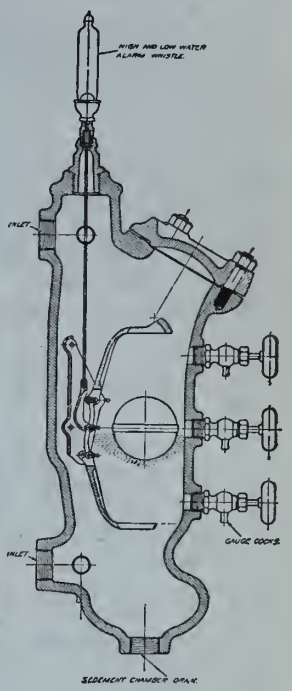

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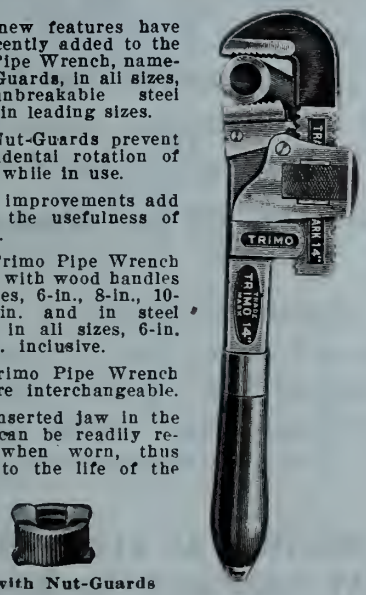

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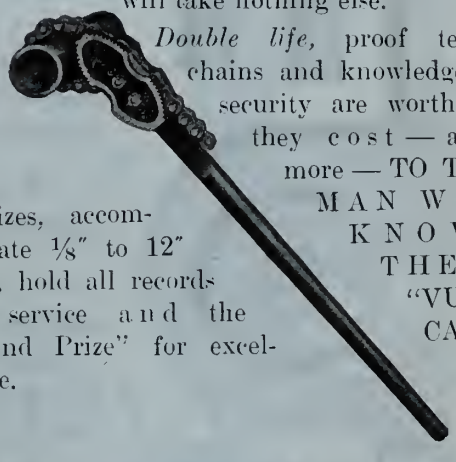

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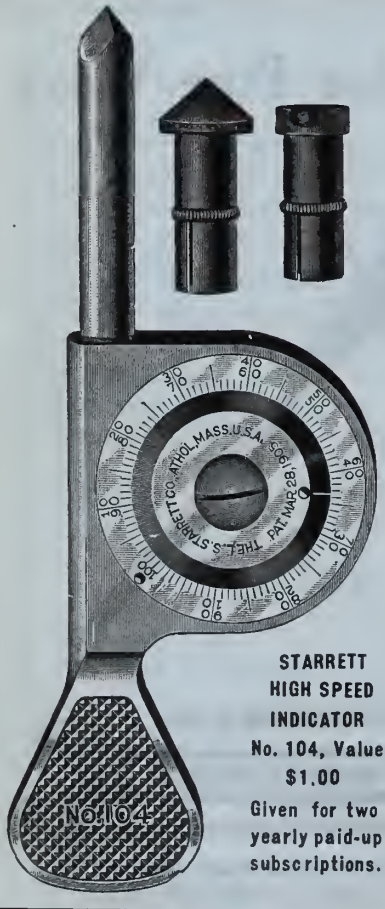

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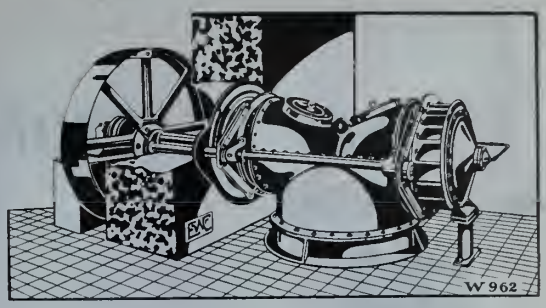

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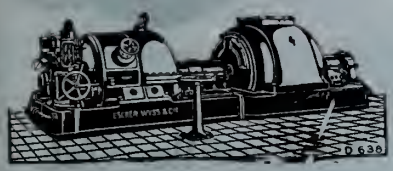

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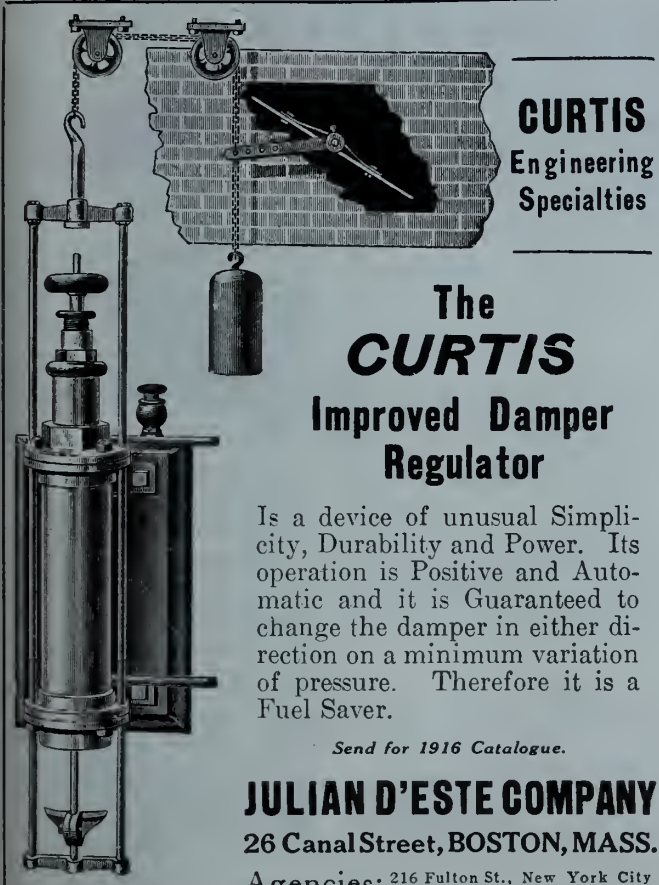

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INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 63
Alberger Heater Co. 68
American Steam Gauge & Valve Mfg. Co. 66
American Steam Pump Co. ... 62
Anderson Co., V. D. 81
Armstrong Cork Insulation Co.. 11
A.S.K. Chemical Co. 54

B

Babbitt Steam Specialty Co.... 72
Babcock & Wilcox 76
Bawden Machine Co., Ltd..... 7
Bennis & Co., Ltd., Ed..... 61
Beveridge Paper Co. 75
Boiler Inspection Dept. 75
Boving Hydraulic & Eng. Co... 74
Bowser, S. F., & Co., Inc..... 63

C

Can. B. K. Morton Co. 15
Can. Detroit Lub. Co. 61
Can. Fairbanks-Morse Co. 65
Can. H. W. Johns-Manville Co., Ltd. 9
Can. Morehead Mfg. Co..... 63
Can. Sirocco Co. 7
Can. SKF Co. 69
Chaplin-Fulton Co. 81
Cling-Surface Co. 71
Coe Co., C. T. 62
Coppus Eng. & Equip. Co..... 7

D

Darling Bros. 6
Dart Union Co. 59
Davis Regulator Co. 60
Dearborn Chemical Co. 8
D'Este Co., Julian 85
Direct Separator Co. 71
Dixon Crucible Co., Jos..... 53
Dominion Belting Co. 72

PAGE

Dominion Coal Co. 74
Durabla Mfg. Co. 66

E

Economy Fuse & Mfg. Co. of Canada 81
Escher Wyss & Co. 85

F

Foxboro Co. 76
Francis, Walter J., & Co. 53
Frick Co. 11

G

Galt Foundry Co. 5
Garlock Packing Co. 57
Garth Co..... 74
Gates, John W. 53
Goldie & McCulloch Co. 18
Graton & Knight Mfg. Co. 70
Greene, Tweed & Co. 67

H

Holmes Metallic Packing, Co... 74
Homestead Valve Mfg. Co..... 85
Hoyt Metal Co. 2

I

Inglis Co., John ..... Inside back cover

J

Jamison Cold Storage Door Co. 12
Jefferson Union Co. 55
Jenckes Machine Co. 2
Jenkins Bros. 3
Jones Underfeed Stoker Co., Ltd. 4
Jordan Bros., Inc. 58

PAGE

K

Kerr Engine Co. 86

L

Ladd, The Geo., Co. 74
Laurie & Lamb 13
Leitch Co., The Arthur S. 58
Liberty Mfg. Co. 49
Linde Canadian Refrigeration Works Co. 10
Lunkenheimer Co. 61

M

MacGovern & Co. 83
MacKinnon, Holmes & Co. 53
Magnolia Metal Co. 56
Martell Packings Co. 66
Mason Regulator Co. 6
McAvity & Sons, T. 60
McDougall Caledonian Iron Works Co. 16
McGhie, W. C. 74
McLaren, D. K., Ltd. 14
Morris Machine Works 62
Morrison Brass Mfg. Co., Jas. Outside back cover
Murphy Iron Works 4
Morse Chain Co. 73

N

Nashua Mach. Works 6

P

Peerless Rubber Co. ..... Inside front cover
Penberthy Injector Co., Ltd... Outside front cover
Pennsylvania Flexible Metallic Tubing Co. 71
Pierce Co., Wm. B. 56
Pratt & Cady Co. 68

PAGE

Precision Instrument Co. 79
Pulsometer Enginering Co. .. 53

R

Roto Company, The 72

S

Sarco Co., Inc. 54
"S-C" Regulator Co., The 60
Scaife, Wm. B., & Sons Co..... 76
Schaeffer & Budenberg Mfg. Co. 7
Smart-Turner Mach. Co. 75
Starrett, L. S., Co. 63
Steel Mill Packing Co. 75
Storey Pump & Equipment Co. 62
Sturtevant, B. F., Co., of Canada 51

T

Taylor Instrument Co. 79
Thomas Grate Bar Co. 5
Trimont Manufacturing Co..... 83
Toch Bros. 51

U

Uehling Instrument Co. 79

V

Vilter Mfg. Co. 10

W

Wall, W. J. 53
Waterous Engine Works Co... 1
Watson & McDaniel Co. 74
Williams & Co., J. H. 83

Y

York Mfg. Co. 12

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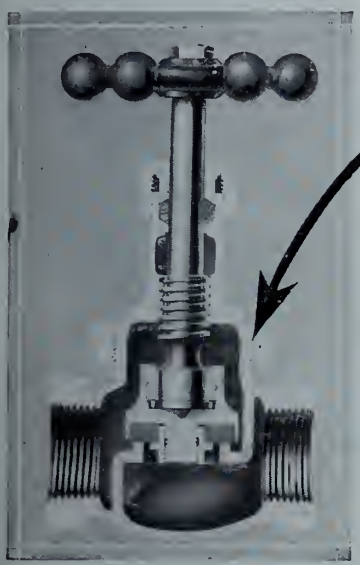

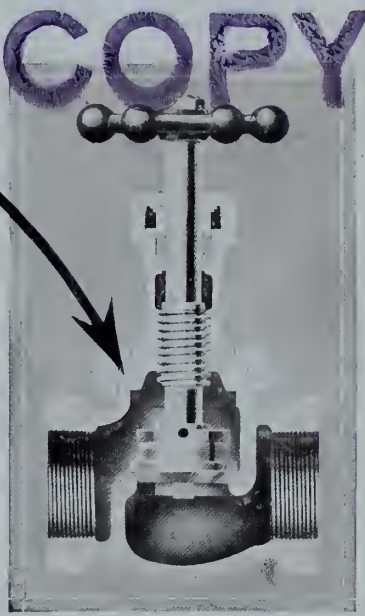

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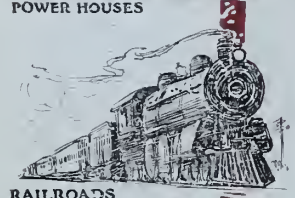
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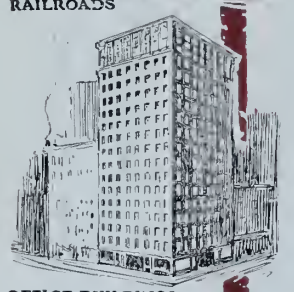
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Over 50,000 engineers regularly specify RAINBOW, because it will make a tight joint that lasts for years.

RAINBOW has been used on every conceivable service in every industry. It's been tested so thoroughly that it is recognized as the standard sheet packing.

RAINBOW fits between the flanges like a mould. It is made of a compound that can't "burn" or "blow-out."

Start to use it to-day--you'll be more than satisfied.

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Peerless Rubber Mfg. Co.

31 Warren Street - New York

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W. G. Harris
General Manager

Delegates to the C.A.S.E. Convention, Your Attention Please!

Gentlemen: Devote an hour of your time in visiting the plant of the Canada Metal Co. during the Queen City Convention.

You will find the visit to our plant interesting. There is something to see there. You will see that our goods are scientifically made, and not products of guess work.

Don't fail us—make it a point to come around. You won't be disappointed. Factory easily reached.

There you will receive a right royal welcome by Mr. Harris, Sr., and Mr. Harris, Jr. (President and Vice-President, respectively, of the company), and members of the staff.

We will be looking for you. Don't disappoint us.

FULL LINE OF BABBITT METAL

IMPERIAL GENUINE
ARMATURE SPECIAL
METALLIC GENUINE
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WHITE BRASS
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WHITE BRONZE
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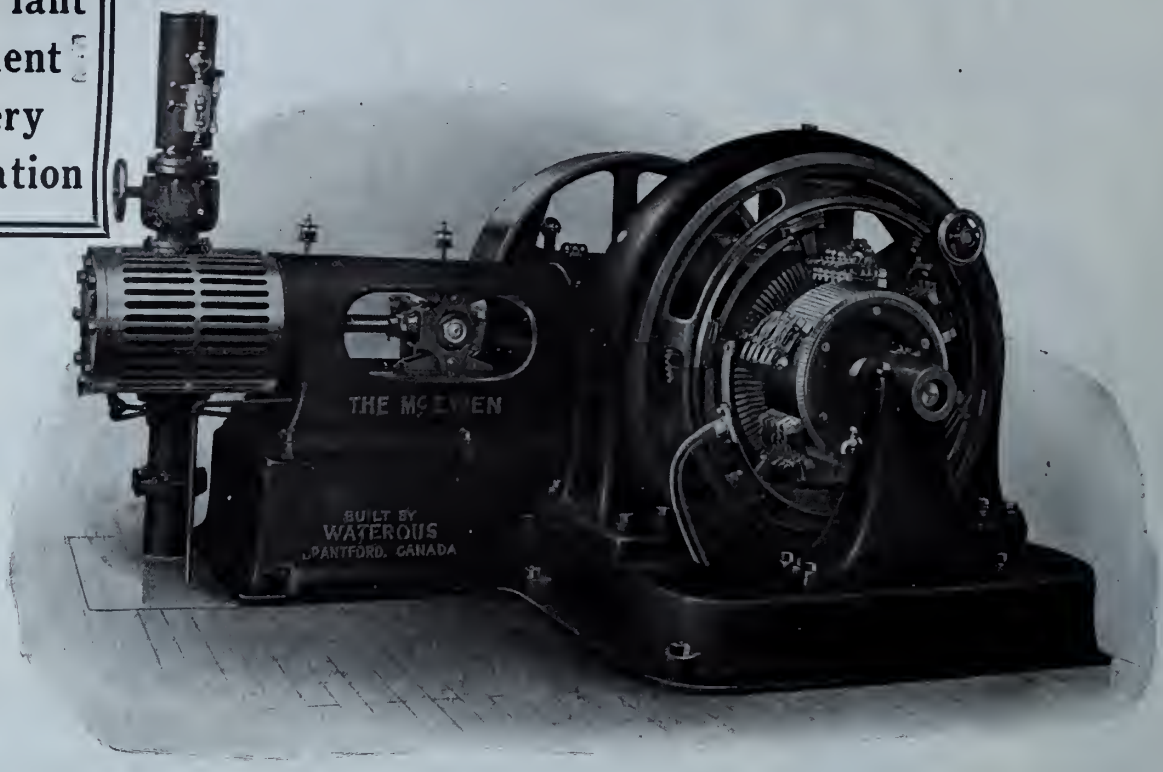
THE CANADA METAL CO., LIMITED

Montreal Hamilton **TORONTO** Winnipeg Vancouver

We Build Complete Power Plant Equipment for Every Installation



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These dependable engines are built for continuous duty. They are your best insurance against costly repair bills and unexpected shut-downs.

They operate quietly and smoothly with an exceedingly close regulation under fluctuating loads. Sturdiness and their large reserve capacity enable them to respond instantly to heavy peak load demands.

Your careful investigation of their actual service performance record in all parts of the country is specially requested. Let us send you our list of McEwen users.

Built in simple and compound units up to 700 H.P. capacity. May we send you descriptive literature?

THE WATEROUS ENGINE WORKS CO., Ltd.

BRANTFORD, CANADA

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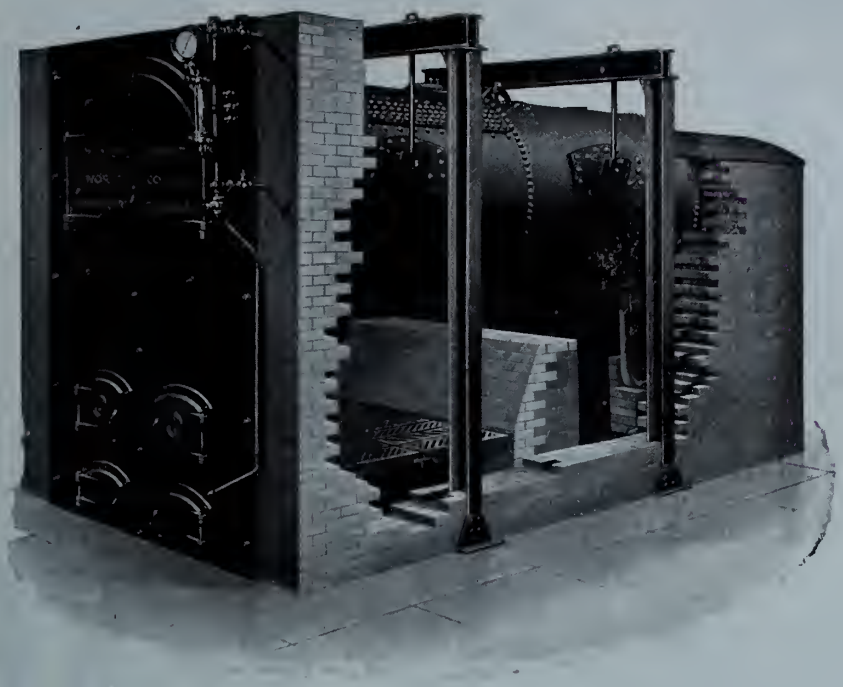
We Build Complete Power Plant Equipment for Every Installation



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In both Stationary and Portable types, Waterous Return Tubular Boilers are specially suitable for every industrial use. They combine economy in fuel consumption, ease and convenience in operation, with absolute trustworthiness.

"Safety First" is not new as applied to these Boilers—it has been the idea behind every detail of their design and construction for fifty years and more. Exceptional care—exceeding the requirements of ordinary Provincial boiler building regulations—has been consistently exercised in the selection of materials and in every operation of their building.

Let the next boiler you buy be a "WATEROUS."

THE WATEROUS ENGINE WORKS CO., Ltd.
BRANTFORD, CANADA

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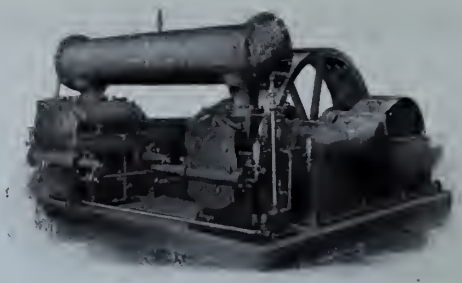
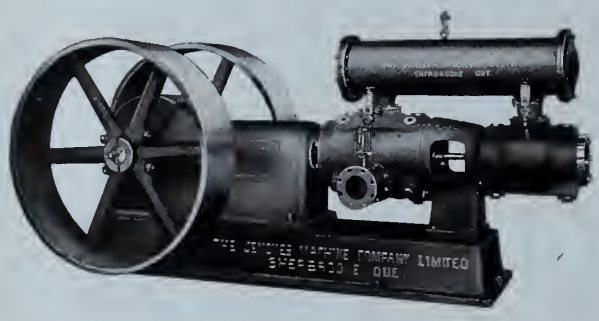
Single Stage



Jenckes Class DB-2 Air Compressor

Inlet valves are of the Corliss type, the outlet valves of the disc type. Lubrication is of the flood type, that is a continuous flood of oil is flowing over the bearings, crank pins, etc., all the time when the machine is in operation. Machine enclosed.

Write for full particulars.



Jenckes Class CB-2 Air Compressor

Two Stage

Our CB-1 and CB-2 compressors are equipped with disc inlet and outlet valves, which gives them long life and high efficiency, and makes them noiseless running. The machines are entirely enclosed. Lubricating system is of the splash gravity type, and the bearings are extra large.

JENCKES AIR COMPRESSORS

The design and construction throughout are of the highest class, the machines being built to successfully stand severe and continuous service. A Jenckes compressor is a paying investment. Write for full descriptive matter.

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Boilers, Engines, Hoists, Pulp Mill Machinery, Stamp Mills, Ore Cars and Special Machinery.

Write for complete description and deliveries.

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Works: SHERBROOKE, QUE. **ST. CATHARINES, ONT.**

JENCKES

C.P.R. North Toronto Station equipped with Jenckes Boilers

Jenckes Boiler Room equipment is seen in many of Canada's foremost factories, institutions and buildings of all kinds. They are r e l i a b l e. The accompanying illustration speaks for itself—an installation in the C.P.R. depot at North Toronto.

Our Boilers are carefully designed and constructed of material that ensures their ability to stand severe service.

We make Horizontal Tubular, Vertical Tubular, Locomotive Types, Heating Boilers, complete steam plants.

The Jenckes Machine Company, Limited

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Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

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BOSTON, MASS.

IN CANADA
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto.

Know Me?

No? Well—I am Schaeffer & Budenberg's "Silent Salesman." "How do!"

My job here is to "take you through" our line—to convince you why you should become acquainted with our complete line of Efficiency Promoting Instruments.

I've got my catalog here and I'm going right through it from cover to cover. So listen carefully—it may mean a whole lot to you. Keep your eyes open for me. See you next month.

"Bye."

Of course, you can have our Special Catalog Set P.H. any time.

The Schaeffer & Budenberg Mfg. Co.

Makers of Pressure, Vacuum and Draft Gauges, Thermometers, Recording Gauges and Thermometers, etc., etc.

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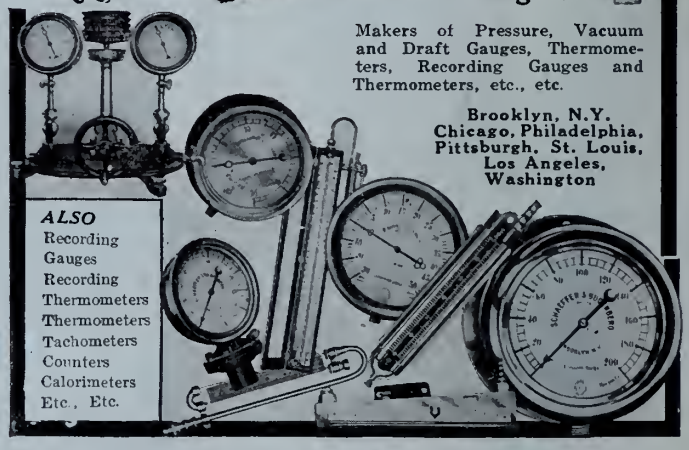

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BAWDEN NEVER SHORT STROKE PUMPS

BAWDEN

General Service Pump

NO Tappets. NO External Valve Gear Levers or Springs. NO Internal Tubes or Stuffing Glands.
Construction is of very best throughout.
The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

Drop a card for full particulars.

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Bundy Steam Traps

When you get heat into water, keep it there! Keep it there and hold it there as long as possible, no matter where the water goes. This is the idea which the makers of the

BUNDY STEAM TRAPS

have been driving home to power plant men for years.

BUNDY STEAM TRAPS
combine Power, Simplicity and Efficiency

Nashua Machine Company

Manufacturers

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If Quality of Manufacture and Reliability in Service

have any meaning in the Engineering World, this list of our leading specialties should appeal to the best judgment of every Engineer and Power Plant Superintendent.

Mason Standard Bronze Reducing Valve

Mason Reducing Valves (Genuine),
Mason Pump Governors,
Mason Pressure Controllers.

Bundy Steam Traps for every service,
Coppus Turbine-driven Blowers,
Sims Hot Water Generators.

Sims Storage Heaters,
Sims Open Feed Water Heaters.

Bundy Oil Separators,
Ashton Gauges and Safety Valves.

Federal Metallic Packing,
Everlasting Blow-off Valves.

Bawden Pumps (Reciprocating & Centrifugal)
Stratton Steam Separators.

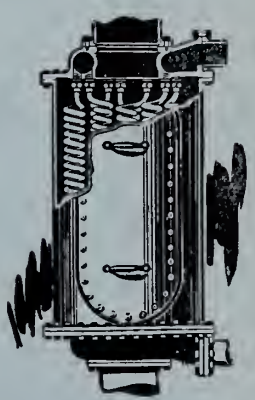
Reilly Multicoil Feed Water Heaters,
Reilly Evaporators and Distillers,
Reilly Multiscreen Feed Water Filters.

New Bundy Return Trap

Mason No. 55 Pump Pressure Regulator

ABOVE EVERYTHING

our Sales Engineers know the *practical application* of our lines to *actual conditions,* and sell from *knowledge,* not from *catalogs.* We furnish *results,* not merely *machinery.*



Reilly Multicoil Feed Water Heater

THIS MEANS REAL SERVICE

Bulletins and full information gladly furnished.

The Mason Regulator & Engineering Co., Limited

Successors to **H. L. PEILIER & COMPANY**

MONTREAL, 380 St. James Street **TORONTO, 311 Kent Building**

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SPEED UP!

BURN THAT COAL no matter how poor. Get every bit of heat out of it and make your boilers develop their maximum capacity.

25 to 100% ABOVE RATING

This is easy when your boilers are equipped with

COPPUS TURBO BLOWERS

As one of our customers said the other day: "We got your blower going and now we are burning dirt." POOR DRAFT? Forget about it. Coppus Turbo Blowers take care of that also.

Perhaps the best proof of the SERVICE that we have rendered to the industrial world is our remarkable growth. Growth is inevitable when a concern provides an article of SERVICE. From a small beginning five years ago our manufacturing activities have expanded until to-day we are occupying the plant illustrated below.

We are to-day the largest manufacturers of Turbo Blowers in the world and without question build twice as many blowers as all the other manufacturers combined, among our customers being concerns who have as many as 150 to 200 blowers in their individual plants—certainly the best proof of satisfactory performance.

We take a natural pride and pleasure in calling attention to the new home of the Coppus Turbo Blower. Occupying nearly an acre of land we have provided for future expansion. 30,000 sq. ft. of floor space is utilized by our manufacturing department, testing laboratory, engineering department, and general offices, while, in keeping with modern practice, suitable quarters have been set aside for the welfare of our employees.

Here we will continue our policy of building integrity into our product. This has won success for us and satisfaction for our customers. We propose to hold our present patronage and add to it by a continuance of this same policy.

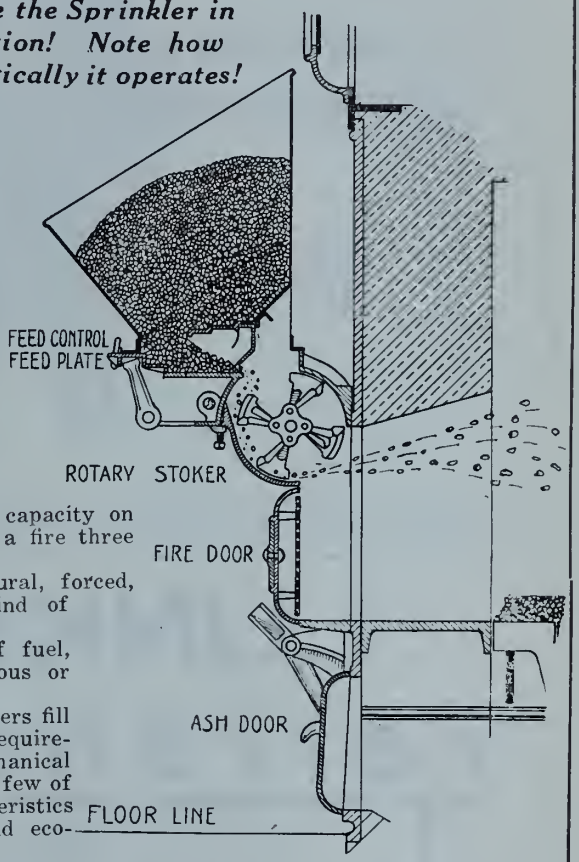
SEND FOR OUR CATALOGUE.

COPPUS ENGINEERING & EQUIPMENT CO., WORCESTER, MASS. 341 PARK AVENUE

Two Type "A" Galt Sprinkler Stokers applied to 150 H.P. Return Tubular Boiler. (Coal Hoppers immediately removable.)

GALT SPRINKLER STOKERS

See the Sprinkler in action! Note how logically it operates!

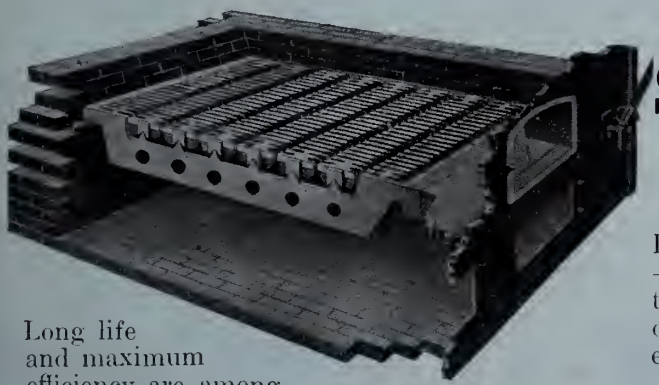


The Stoker mechanically feeds and perfectly spreads the fuel over the entire length and width of your present grates with the fire doors closed.

1. **Effects a saving in coal from 10% to 20%.**
2. **Effects a saving in labor from 25% to 50%.**
3. **Gives a brilliant, thin, perfectly level fire.**
4. **Gives smokeless combustion.**
5. **Increases the boiler capacity.**
6. **Increases the percentage of the CO.**
7. **Burns the fuel completely to the finest ash.**
8. **Operates for years without need of repair.**

Gives 170% boiler capacity on natural draft with a fire three inches thick.
Operates with natural, forced, induced or any kind of draft.
Burns any kind of fuel, anthracite, bituminous or lignite.
Galt Sprinkler Stokers fill every practical requirement of a mechanical stoker. Here are a few of the many characteristics of this efficient and economical appliance.

We supply Power-Turbo Blowers, McNaughton Rocking Grates, Damper Regulators and other Power Plant Equipment. Send for illustrated catalog.



Long life and maximum efficiency are among the outstanding features of the McNaughton Sectional Rocking Grate Bar.

McNAUGHTON
Sectional Rocking Grate Bar

Over 1200 in use in the Power Plants of the Country

Every user of this cost-cutting fixture is a booster for it—they all find it a success beyond their greatest expectations. It insures complete combustion of every pound of coal. Only ashes slip through the grate and this is effected by rocking—there's no waste.

Simple and durable in construction. Adaptable to all types of boilers and fuels.

THE GALT FOUNDRY COMPANY, GALT, ONT.

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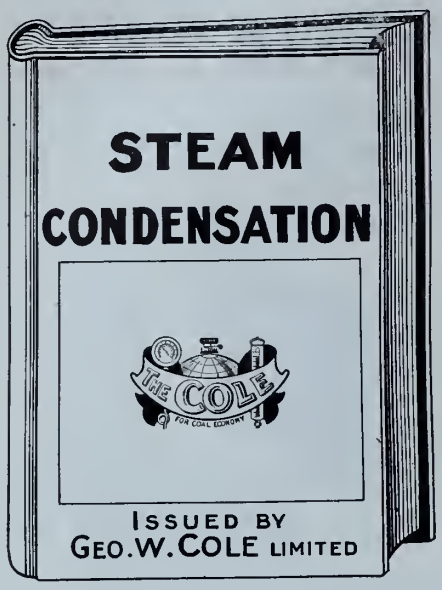
"STEAM CONDENSATION"

Is the title of our new Book

NOT A CATALOGUE

There is no other Book like it for practical work. It's really instructive—and treats Condensation in such a manner, that the subject is interesting to Engineers, Superintendents, Factory Managers, etc., and shows how losses are turned into profits.



Send for your copy---It's free---It's worth while.

Geo. W. Cole, Limited, 838 Dundas St., Toronto

LUNKENHEIMER
"Ferrenewo" Valves

The "Ferrenewo" embodies many exclusive features of construction, which not only give the greatest strength, but also increase the wearing life of the various parts, and consequently the valve as a whole.

The "Ferrenewo" is one of several Lunkenheimer Valves provided with the Lunkenheimer "Seat-guard," an annular extension on the bottom of the disc, which materially aids in preserving the seating surfaces and keeping them clean.

The "Ferrenewo" has a nickel Seatring and Disc, which, together with all other parts, are easily renewable.

The union bonnet, shoulder on stem for repacking under pressure, deep stuffing box with gland, etc., are other details which contribute to the efficiency of the valve.

Specify Lunkenheimer "Ferrenewo" and insist on having the genuine.

Your local dealer can supply you; if not, write us.

THE LUNKENHEIMER CO.

"QUALITY"

Largest manufacturers of
High Grade Engineering Specialties
in the World

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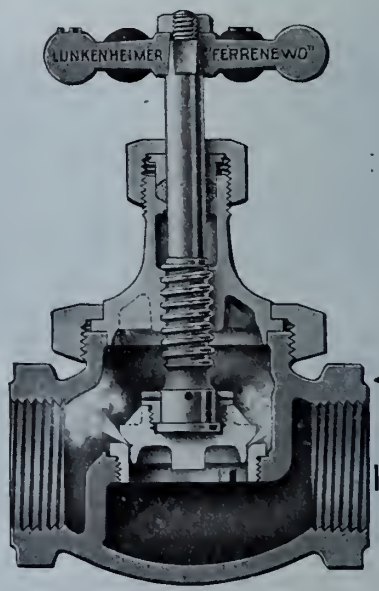

Write for Booklet No. 567-DC

A Hearty Welcome to the Delegates and Visitors to the Annual Convention of the Canadian Association of Stationary Engineers, and a cordial invitation to visit our Booth in Exhibit Hall.

2-10-43

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Economy from any Standpoint

Installation, operation, upkeep and duration. These are four points on which the Dart Unions have proven themselves to be strong.

The joint is bronze to bronze. This does not allow rust or corrosion. The seat is ball-shaped, which allows perfect connection regardless of the alignment. The threading is full and clean-cut and exact to size. Once installed there is no need for further thought.

Your dealer sells them.

Dart Union Co., Limited

Toronto Ontario Canada

Installation Shows Two 600 H.P.

ROBB
Water Tube Boilers

Designed for 200 lbs. working pressure, installed in the power plant of the Goodyear Tire & Rubber Company of Canada, Limited, New Toronto, Ontario. Each boiler consists of longitudinal drums with flanged headers, and seamless steel tubes.

WE also manufacture Water Tube Boilers with Cross Drums, and have supplied 3,600 H.P. to the Dominion Government for the Lauzon Dry Dock near Levis, Quebec; 4,000 H.P. to the Aetna Explosives Company at Drummondville, Quebec, and approximately 2,400 H.P. to the Spanish River Pulp & Paper Mills, Limited, for their plants at Sturgeon Falls and Espanola.

WE build Horizontal Return Tubular Boilers, and have Installed Continental Scotch Marine Boilers at the instance of the City of Toronto in the new Filtration Plant on the Island.

THE ROBB-ARMSTRONG Vertical and Horizontal Steam Engines as prime movers for electric light and power purposes have been standard in Canada, Australia, and the countries of Europe for many years. Numerous successful installations might be mentioned, including Head Office Building of the Bank of Toronto, Canadian Pacific Railway Building, Traders Bank Building, T. Eaton Company, Limited; Robert Simpson Company, Limited; Nova Scotia Steel & Coal Company, Sydney Mines, N.S.; Canadian Pacific Railway Elevators, Fort William, Ontario; Perth, West Australia; Cleethorpes, England; Barcelona, Spain; Sao Paulo; Manchester, England.

WE have just completed the following installations of Rolling Mill Engines: Dominion Iron and Steel Company, one roughing engine 36" x 48", main bearing 21" x 33", and crank pin 15" x 12". Also one pair of 24" x 48" finishing engines. Fitted with piston valves. The Canadian Car & Foundry Company, one 42" x 48" Engine fitted with Corliss valves. Star Manufacturing Company, Dartmouth, N.S., one 22" x 24" Corliss type engine.

We are at present building a pair of 25' x 36" centre crank engines for the Armstrong, Whitworth Company of Canada.

If you will investigate our product you will find that it ranks first for design and service.

INTERNATIONAL ENGINEERING WORKS, Limited

AMHERST, N.S.

Montreal Toronto Winnipeg Calgary Vancouver

Mention this paper when writing advertisers. It will identify the proposition about which you require information.

Just a Ball—that's all

Two fundamental laws of physics vouch for the Johns-Manville Steam Trap

IF you believe that steam under pressure exerts its pressure in every direction and that a floating body rises and falls with the rise and fall of the water level regardless of water depth—then you'll believe in the Johns-Manville Steam Trap, for these unchanging laws control it.

There's just one moving part—the hollow ball—and it's operated solely by these two forces: Pressure, which holds it against the discharge orifice—the only point where there's an unbalanced pressure—and Buoyancy, which supplies the lifting force as the water level rises. So when condensate accumulates, the ball rolls up and exposes the discharge; when the water level falls, the ball rolls down and seals it. Positive in action, no air-binding, no steam-leakage.

The sureness of operation and the simplicity of the Johns-Manville Steam Trap mean freedom from trap troubles—and this isn't theory but fact, as hundreds of installations show. You can prove it for yourself at small cost by trying one out.

THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED

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JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

JOHNS-MANVILLE STEAM TRAP

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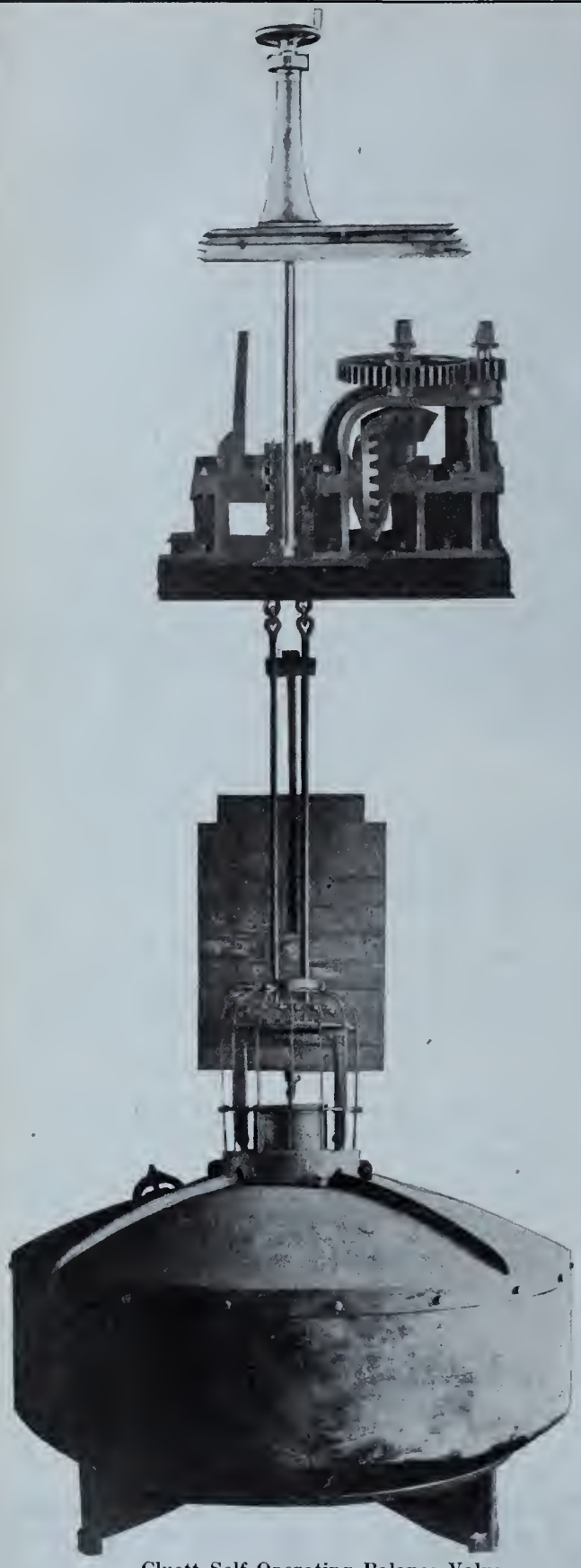


Cluett Self-Operating Balance Valve.
Patent No. 107480, Sept., 1907.
Built by Victoria Foundry Co., Ltd.

The Class of Work We Are Equipped For

A Cluett Self-Operating Balance Valve, four of which were installed by us at St. Andrews' Rapids Locks, Winnipeg.

Eight turns of the 8-in-hand-wheel opens a 60-in. valve.

Our Engineering Department will be pleased to quote you on work of this nature.

We also build Stop-log winches and other power-plant equipment.

Write us for further information. We are always available for consultation.

The Victoria Foundry Co. Limited

OTTAWA, ONTARIO

We Analyze the Water Before Preparing Treatment

Dearborn Feed Water Treatment is based on Knowledge—not Guesswork

Dearborn Treatment is based upon expert, scientific analysis of a sample of the boiler feed water you are using. The analysis, tests and compounding of the correct remedy are conducted in the largest, most modern, and thoroughly equipped laboratories and manufacturing plant devoted to the science of water treatment in existence.

In our twenty-five years' experience we have analyzed and treated waters of all classes, in many countries and under widely varying mechanical conditions. The knowledge and experience gained from this broad handling of the subject are brought to bear in the consideration of new propositions, to the direct advantage of the customer.

Dearborn Feed Water Treatment is made to suit the actual water conditions shown by analysis of the water used. It is not a "cure-all." It counteracts the elements that cause scale, pitting, corrosion or other troubles chargeable to bad feed water.

Send us a gallon of your feed water; we will send you a report of analysis and tell you exactly how much Dearborn Treatment prepared specially for your case will cost.

Dearborn Chemical Company of Canada, Limited

1220-30 Dundas Street, Toronto Ontario, Canada

If any advertisement interests you, tear it out now and place with letters to be answered.

Nonpareil Cork Covering installed 11 years ago.
Sinton Hotel, Cincinnati, O.

Still Good After 11 Years

Back in 1905 the brine lines shown in the illustration were insulated with Nonpareil Cork Covering. Since that time—for over eleven years—the Nonpareil Cork has been keeping the cold in and the heat out, day after day. And it is still good for a long period of service.

That's the big advantage in using Nonpareil Cork Covering for Cold Pipes.

Not only is Nonpareil Cork a more efficient covering at the start, but it retains this efficiency and does not require costly repairs and replacements. Usually a coat of asphaltic paint every twelve months is sufficient to keep it in first-class condition.

The reason? Nonpareil Cork Coverning does not absorb moisture from the air by capillary attraction. It is made of nothing but cork.

Samples, prices and full information on request.

Nonpareil Cork Covering
For All Cold Pipes

Armstrong Cork & Insulation Co., Ltd.
504 McGill Building, Montreal, Quebec.

Also manufacturers of Nonpareil Corkboard for all cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings, furnaces, etc.; Nonpareil Cork Machinery Isolation for deadening the noise of machinery; and Circle A Cork Brick for cold storage room floors.

UEHLING WASTE METER

COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO_2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO_2 Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO_2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

CO_2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company
2008 Empire Building New York City

Tycos
Temperature Instruments

INDICATING RECORDING CONTROLLING

H&M Type Angle and Straight Stem Thermometers

Tycos Recording and Indicating Thermometers

Automatic Temperature and Pressure Regulators

Mercury Vacuum and Absolute Pressure Gauges

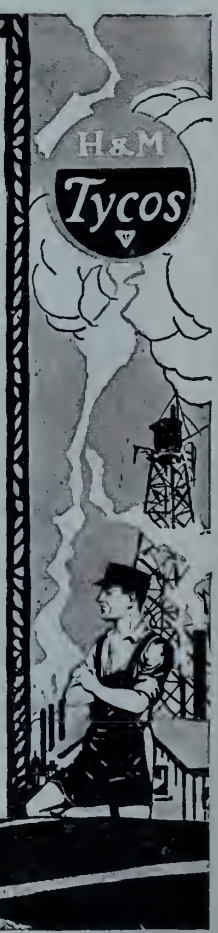
Engraved Stem Thermometers

Hygrometers, Hydrometers

Thermo-Electric and Radiation Pyrometers

In spite of the nation wide agitation in form of automatic and positive mechanical regulation and indication, there still remain many industrial establishments which are not properly equipped in all departments with *Tycos* profit-earning instruments.

To all such we offer our extensive experience to help them select the installations best adapted to their needs. Correspondence solicited.



H&M Division
Taylor Instrument Companies
Rochester, N.Y.
There's a *Tycos* or *Taylor* Thermometer for Every Purpose

NO. 119 201 Royal Bank Building, Toronto, Ont.

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LINDE

The Standard Refrigerating Machine

THE selection of Refrigerating Equipment for your business is essential to proper efficiency and economy. The selection of the particular type of machine you will use involves the same serious consideration as the selection of any other feature of equipment in your business.

Among others, Linde machines show indisputable constructional advantages combining the accepted features of design which are common, with certain individual features adding to strength, excess load carrying capacity, operating economy and availability for this particular work. Each type presents highly individualized construction adapting it in the fullest degree to the work it is called upon to do.

Twenty-one years of manufacturing prestige with a constantly increasing volume of business, and a record of re-sales to satisfied owners are your guarantee of satisfaction.

The Linde Canadian Refrigeration Co., Limited

37 St. Peter St., Montreal

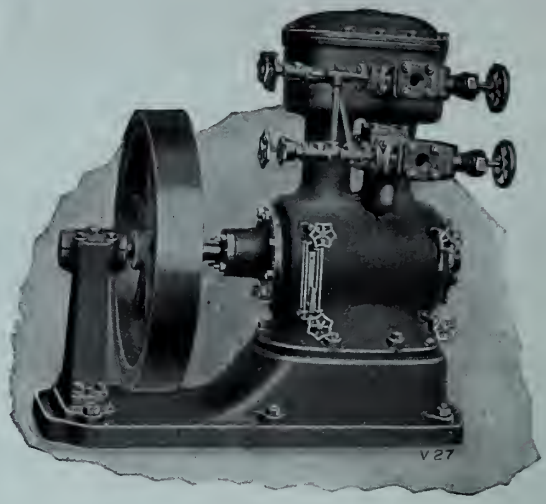
Established and Manufacturing in Canada since 1896

A WINNER

During the past year hundreds of our enclosed type machines have been sold and are operating to the entire satisfaction of our customers. They are properly designed, and nothing but the best material and skilled workmanship used throughout, the same as has been our practice for over thirty-five years in the construction of our larger size vertical and horizontal types.

May we figure on your next installation, regardless of size or type, without obligation to you.

Write us any time and any place.



Size 1-25 tons

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives: THE FRICK ICE & REFRIGERATION CO., Montreal, Canada

DOORS

For Cold Storage and Freezer Purposes Either Standard or Fireproof

JAMISON'S "JONES" and "NOEQUAL" doors are SUPERIOR because :

1st—Only the best materials are used in their construction.
2nd—We use heavier materials. Result: Longer life and increased efficiency.
3rd—Our doors are built with double and triple seals of contact—others have but one.
4th—Our Automatic Self-Tightening Fastener is the only truly AUTOMATIC and SELF-TIGHTENING Fastener on the market.
5th—Our ADJUSTABLE SPRING Hinges mean the door is always properly seated in the frame, making sagging impossible.

Write for General Catalog No. 7, illustrating and describing both "Jones" and "Noequal" doors, windows, ice doors and chutes, etc.

Jamison Cold Storage Door Company

Formerly Jones Cold Store Door Co. HAGERSTOWN, MD., U.S.A.

The VILTER MANUFACTURING CO.

Manufacturers of

ICE MAKING and REFRIGERATING MACHINERY, CORLISS and POPPET VALVE ENGINES, ETC.

242 Beecher Street, Milwaukee, Wisconsin, U.S.A.

Branch Offices:

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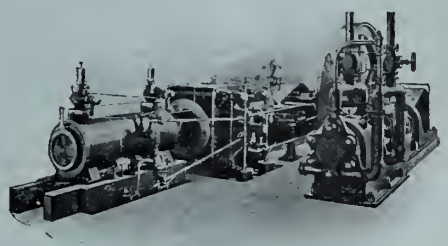
Products

Vilter Rolling Mill and Girder Corliss Engines, Poppet Valve Engines, Ice Making and Refrigerating Machinery, "Badger" Pasteurizers for Pasteurizing Milk or Beer In-The-Bottle. Machinery for Breweries and Bottlers, etc.

Vilter Improved Poppet Valve Steam Engine

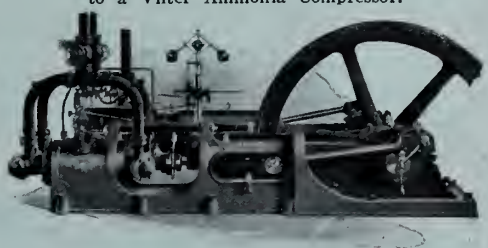
Vilter Poppet Valve Engines effect real power plant economy. We know our statement will be attested to by owners and operating engineers of the plants where Vilter Poppet Valve Engines have been installed. Your request for proof need entail no obligations to purchase.



Vilter Tandem Poppet Valve Engine, direct connected to a Vilter Ammonia Compressor.

Vilter Rolling Mill Type Ammonia Compressor

The Rolling Mill Type Compressor is built along very heavy lines and for all conditions of service. It is used only with slight modifications in all sizes of compressors. The general design is very pleasing to the eye, the machine making an artistic asset to any engine-room. Its very appearance gives assurance and proof of its strength and reliability. This type is built in sizes from 6 Tons to 25 Tons daily refrigerating capacity.



Rolling Mill Type Compressor.

Vilter Duplex Heavy Duty Ammonia Compressors

A Duplex steam-driven unit, with horizontal double-acting ammonia compressors and direct connected to Cross Compound Corliss Engine. Compressor equipped with multiple valve heads, giving maximum area. Stuffing box of the double-packed type, with oil seal and pressure release. The duplex type is built in sizes from 125 to 750 tons.

Vilter Small Capacity Vertical Ammonia Compressor

A vertical single-acting compressor, specially designed for users of comparatively small quantities of refrigeration. Made in both single and twin cylinder units. The single units, either belt or steam driven, are made in sizes from 1 ton to 12 tons daily refrigerating capacity. The twin cylinder units, belt driven only, are made in sizes from 2 tons to 25 tons daily refrigerating capacity.

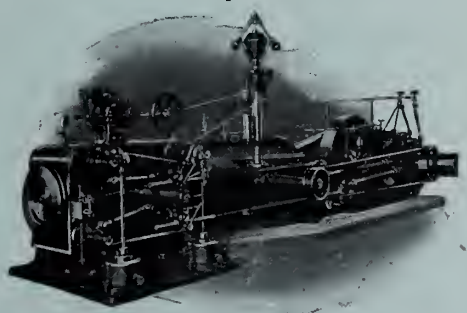
Vertical Ammonia Compressor.

Vilter Rolling Mill Type Corliss Engine

The Rolling Mill type Corliss Engine is of exceptionally massive construction throughout, and is adapted to any class of service from the steady belted load to the direct connected electrical service, in which the engine is subjected to heavy and extremely variable loads. It is built for high steam pressures and high rotative speeds, and may be used with superheated steam up to 100° F. superheat.

Vilter Girder Frame Corliss Engine

is exceedingly strong and rigid, and is designed to take shocks and overloads without possibility of misalignment. Made in 26 sizes, from 25 h.p. up.



Rolling Mill Type Corliss Engine.

LITERATURE. Bulletins, catalogues and full data regarding our products will be mailed upon request.

The Finest Ice-Making Plant In Canada

THE illustrations show equipment designed, furnished and installed by us in the Dupont Street Plant of the Lake Simcoe Ice Supply Co., Limited, Toronto.

Although the plant is only rated at 75 tons capacity per 24 hours, when pushed it has turned out 20% more ice than this amount. It is of the very latest design, embodying all features known at the present time for producing ice of the best quality most efficiently.

It will pay you to consult us regarding your requirements in this line.

18" x 28" "York" Ice Machine showing side next to Motor.

Canadian Ice Machine Co. Limited

80-82 Chestnut Street, TORONTO

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UNDERFEED AUTOMATIC STOKER

Eliminates Smoke and Makes More Steam With Less Coal

It is a well-established fact among steam users now that the mechanical method of firing is cheaper and more efficient by far than the old hand method of firing.

You get more steam from less coal—and furthermore all smoke nuisances are banished.

Since it is generally conceded that mechanical methods of stoking are best, it is then a question with you, which is the best of the mechanical methods. Your attention is directed to the **Jones Underfeed Automatic Stoker.**

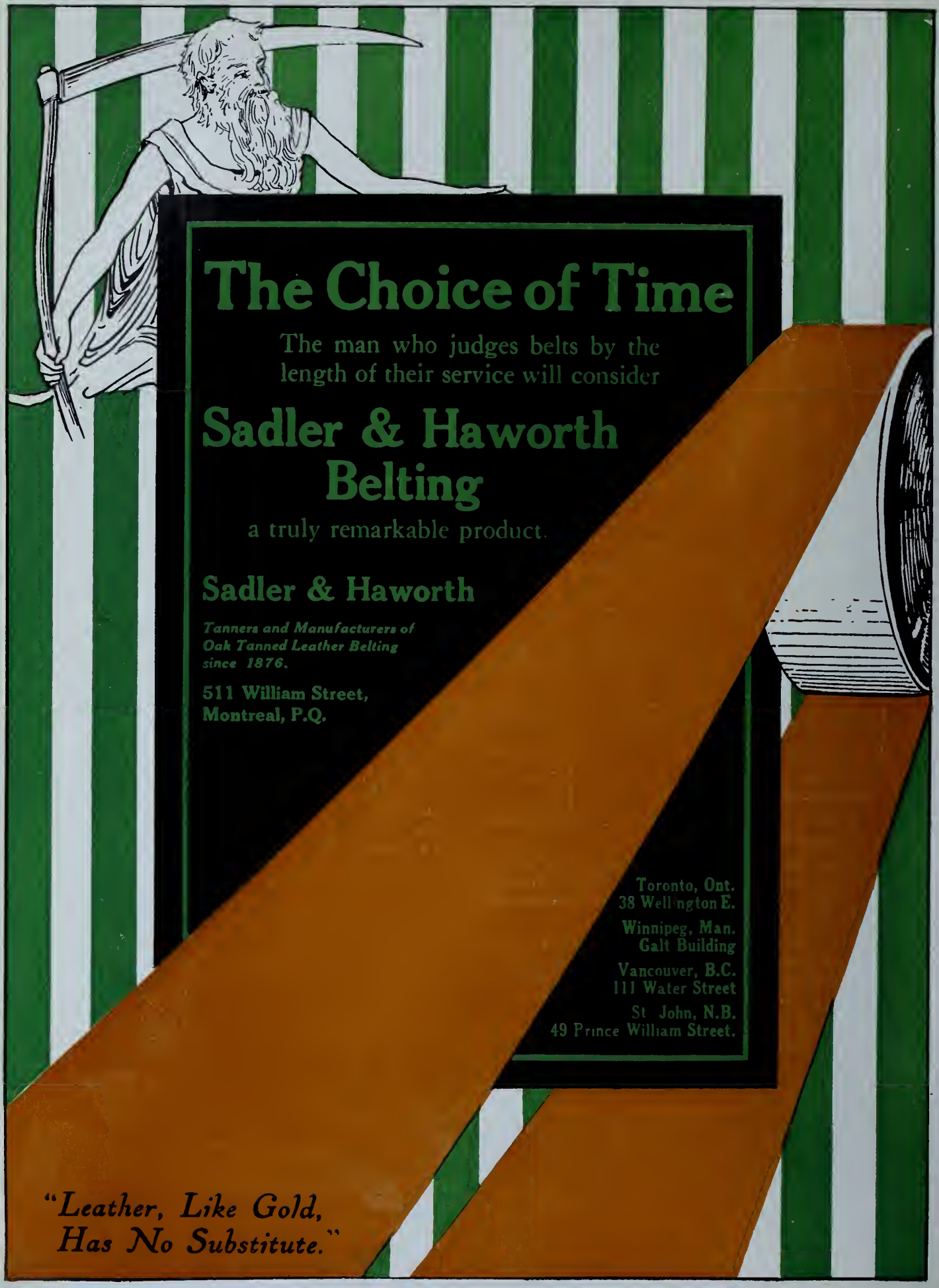
The Jones Stoker maintains a constant steam pressure because of the automatic control of air supply and coal supply. It increases boiler horse-power developed by its unlimited capacity to feed coal and simultaneously introduces extra air required in proper proportion for combustion. Immediately responds to fluctuating loads and sudden demands for steam. No soot! No smoke! Burns any kind of coal! Let us tell you the reason why.

There are a lot of interesting things to tell about the Jones Stoker. Give us your address.

Jones Underfeed Stoker Company, Limited

37-41 BRITAIN ST. TORONTO

The "Jones" embodies the most practical features of mechanical stoking known to science. Underfeed stoking is the only device for burning coal which utilizes as fuel all volatile ingredients. So there is no waste with the **Jones Underfeed** Stoker in action—everything that should be burned to generate steam is consumed.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The man who judges belts by the length of their service will consider
Sadler & Haworth Belting
a truly remarkable product.
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Tanners and Manufacturers of Oak Tanned Leather Belting since 1876.
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"Leather, Like Gold, Has No Substitute."

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A Remarkably Strong Belt

Stands a breaking strain 50% greater than leather and 25% more than rubber belting.

For Transmission of Power or Conveying

High in efficiency, economical and true running.

Try one "Maple Leaf" Belt and you'll want more.

"Maple Leaf" Belt Dressing

The best for all kinds of belts.

Write for Prices.

Dominion Belting Co., Ltd.

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Quebec Branch—51 Duluth Building, Montreal

Jeffrey Pivoted Bucket Carrier—18"x24" Buckets over Large Storage Bin, showing Buckets being dumped by traveling Tripper Installed at New Power House of Transue & Williams Co., Alliance, Ohio.

JEFFREY

Conveyer passing from basement into the lifting strand. Note its neat and thoroughly substantial appearance.

The Jeffrey Pivoted Bucket Elevator Conveyer

is the Super-Service Carrier for Power Plants and large Storage.

In the Design and Manufacture of this Carrier, "Reliability First" has been considered paramount; coupled with a maximum of material strength and hardness of wearing surfaces throughout.

Carriers furnished in suitable sizes for handling large and small capacities.

The Jeffrey Complete Line of Coal and Ashes Handling Equipment includes Conveyers of various types; Elevators; Weigh Hoppers; Valves; Spouts; Screens; Chains for all services; Coal Crushers; Pulverizers; Power Transmission Machinery; Haulage Locomotives; Wagon and Truck Loaders; Etc.

Get the benefit of our many years of operating and field experience. Our Engineering Experts will gladly co-operate with you in solving your Coal and Ashes Handling Problems.

Send for our latest catalogs and bulletins.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms

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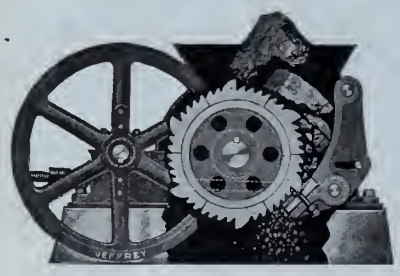


The Jeffrey Single Roll Crusher

Will, in one operation, reduce your run-of-mine coal to the proper size for greatest stoker efficiency.

Write for Crusher Bulletin No. 141-4.

Handling ashes with a Jeffrey "Reliance" Drag Chain Conveyer at the power plant of the Otis Elevator Co., Yonkers, N.Y.

JEFFREY "RELIANCE" DRAG CHAIN

This type of chain operating in a cast iron trough, as illustrated in the opposite photograph, is proving highly economical and efficient in the handling of ashes, clinker, and other abrasive materials.

Bulletins Nos. 154 and 155 picture two very interesting installations at the power plants of the Otis Elevator Co., and the American Iron & Steel Mfg. Co. Send for copies.

D. K. McLaren's

GENUINE BRITISH-OAK TANNED

LEATHER BELTING

TRADE MARK

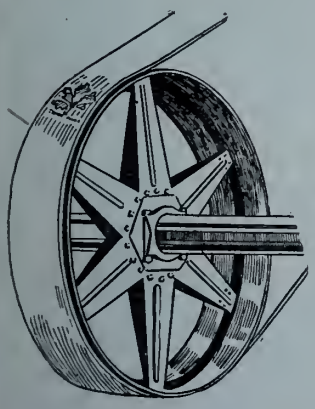
More for Your Money

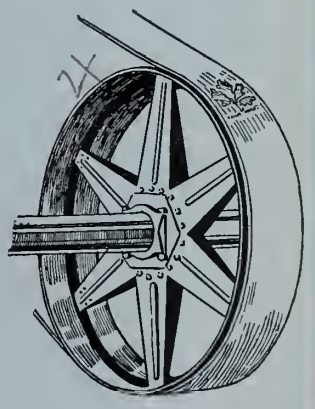
D. K. McLAREN'S BELTING has "made good" in so many instances that it is pretty safe to say that it gives you more for your money than the belting you are now using.

If you are noticeably losing time through slippage and breakage it is not probable, but CERTAIN, that D. K. McLAREN'S BELTING will give you more for your money; for this **GENUINE BRITISH OAK-TANNED PRODUCT** gives all the efficiency within the range of possibility, or, in other words, all belts must slip a little and break sooner or later, BUT McLaren's is a minimum slipper and a minimum breaker.

Our time-tested British Oak tanning process assures strength, durability and pliability to all our belts.

Let us put you in touch with some users of our belts. Write to-day.





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FOR HIGH SPEED ENGINES

Encanto, Calif.,
March 3, 1916.

Magnolia Metal Co.,
Gentlemen:—

You may use this letter for publication, if the same will in any way help to further your best interest.

Your metal has given me the best satisfactory results in high speed engines.

I have used this metal for main bearings and crossheads, it has stood up under all conditions and I never have found MAGNOLIA METAL anything but what you have represented it to be.

Very respectfully yours,
J. L. WURTHMANN.

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MORSE Silent Chain POWER TRANSMISSION

There are many "Silent" Chains, but only one has the "Rocker-Joint".

The Exclusive Patented Feature of THE MORSE, distinguishing it from all others.

means

Sensible Conservation
and
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The Law of the Land To-day:
"Get All The Power You Pay For"

This is possible: But *only by using the Morse "Rocker-Joint"* wherever power is used. *Why?* Because the *"Rocker-Joint"* is the Only Frictionless Joint.

Results:

1. No Power Loss. 2. Longest Service.
3. Minimum Lubrication. 4. Highest Speed.

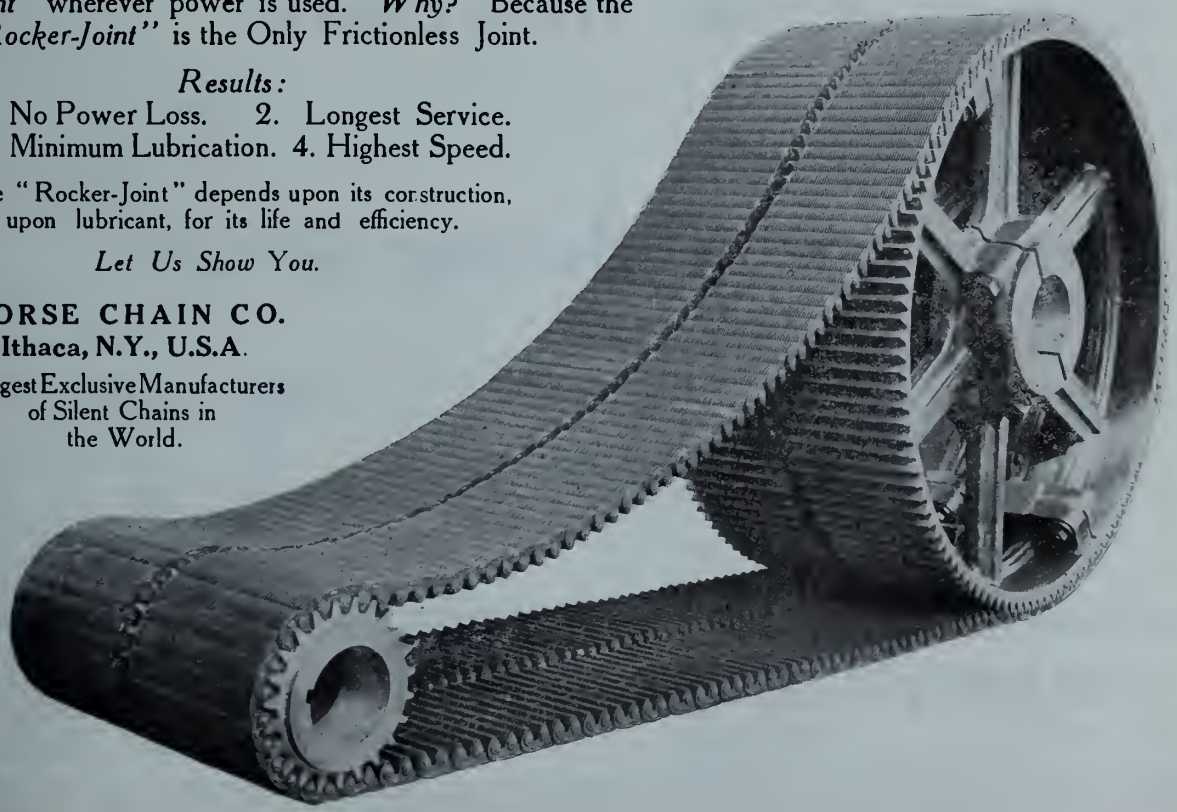
The "Rocker-Joint" depends upon its construction, not upon lubricant, for its life and efficiency.

Let Us Show You.

MORSE CHAIN CO.
Ithaca, N.Y., U.S.A.

Largest Exclusive Manufacturers of Silent Chains in the World.

C-8



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Lyman Service from Stock

From our Warehouse in Montreal and Toronto we are prepared to make IMMEDIATE SHIPMENTS of most of the lines named above. On the others we are in a position to secure the best deliveries that can be obtained under existing conditions.

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For our customers' accommodation we maintain our own purchasing office at 1554 Equitable Bldg., New York City, under the management of Mr. K. E. Gury. Our experience and connection enable us to locate, and ship at once, much-needed supplies which our customers have been unable to obtain elsewhere.

Let us demonstrate the LYMAN Service to you!

LYMAN TUBE & SUPPLY CO., Limited
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The Bond Patent "Spiro"

The PRICE is never right if the quality is wrong. QUALITY in Power Transmission Equipment means correct design based on long experience and skill in manufacturing and finishing.

When you buy BOND Transmission machinery, you know the quality is right, for we have had twenty-five years' experience.

And at the same time BOND transmission equipment can be bought at prices as low as are now charged for many inferior lines.

Write to-day for our complete catalogue.

Canadian Bond Hanger & Coupling Co., Limited

Alexandria, Ontario

The Original Four-Point Hanger

"That belt must be slipping, George! It's too loose on the pulleys!"
"No it isn't, Uncle. If it slipped at all, it wouldn't stay on the pulleys a minute!"

THE new Superintendent was different. For the first few days he just walked through the plant and looked at things. Down in the engine room he took the speed of the engine. Up in the shop he took the speed of the main shaft. Then he did some figuring. These are the figures.

Driving pulley 8 feet diameter.
Speed 80 rev. per minute.
Driven pulley 4 feet diameter.
Speed should be 160 rev. per minute.
Speed actually.. 155 rev. per minute.
Loss ..... 5 rev. per minute.
5 ÷ 160 = 3% approximately.
8 ft. × 3.1416 × 80 rev. per minute = about 2,000 feet per minute the belt travels.
3% of 2,000 feet = 60 feet per minute LOST.
Pulley centres at 20 feet, so belt length approximately 60 feet.

This meant that once every minute his belt was useless, for the loss in feet per minute due to slipping was more than the length of the belt itself!

In a ten-hour day this loss would be 36,000 feet, so that every day the engine had to give that belt a free ride of nearly 7 miles! And the firm paid the bills at the coal pile and machines, at the bearings, pulleys and in the belt itself. It didn't look right.

The plant had over one hundred belts. If they all slipped, the firm must be losing hundreds of dollars a year in power, time and equipment which might better be saved.

* * * * *

The new Superintendent never did things on impulse, or merely on someone else's say-so. Back in his experience he had used CLING-SURFACE, the treatment which PREVENTS SLIPPING, and allows the usual drive to be run easy or slack under full load. He knew that it makes constant tension unnecessary, preserves and makes the belts thoroughly pliable and waterproof; that it is not sticky, contains no rosin or anything harmful, and is safe, easy and economical to use.

So he had every belt treated, and the effect was seen at once. His slipping stopped, he had more and steadier power, and not a belt has been taken up since that time.

This is fact; we can prove it on your drives to YOUR satisfaction. Just ask for THE PLAN 10,000 firms have found successful.

And remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface Co.

1057 Niagara Street
Buffalo New York

If any advertisement interests you, tear it out now and place with letters to be answered.

Good News Travels Fast

The Fame of Hoyt Metals Reaches Round The World

OUR LEADING LINES—

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These three lines cover every Babbitt requirement and they do it with the utmost economy.

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Super-wearing qualities of HOYT METALS will considerably reduce your babbitt costs. For nearly half a century we have given every mechanical, physical and chemical test known to the science of metals to ensure the BEST THAT CAN BE MADE. Customers in every part of the world testify to the success of our efforts.

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Hoyt's Solders Excel—Made in Bar and Wire

HOYT METAL COMPANY

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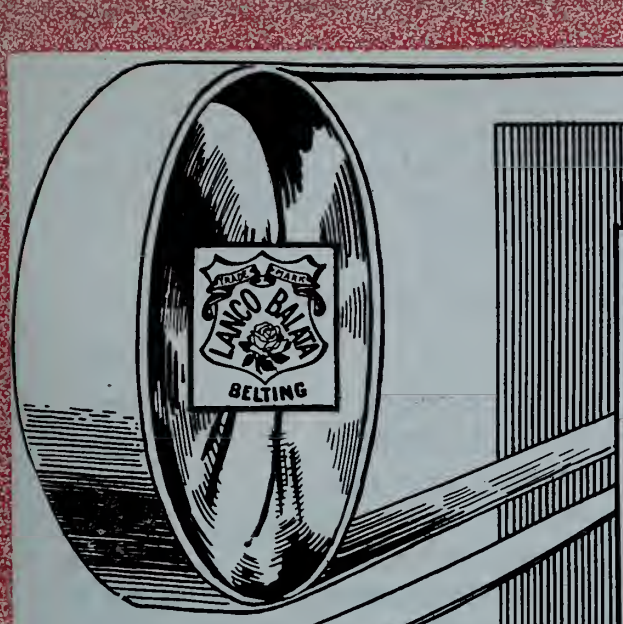

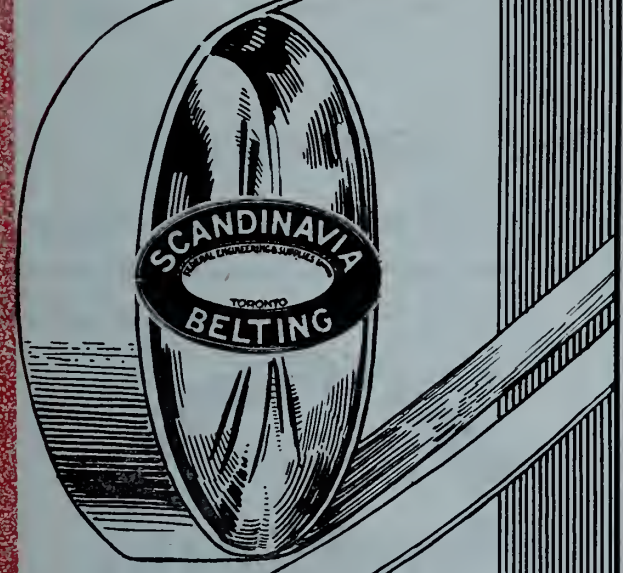

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Lanco Balata Belting

A really waterproof belt and as nearly stretchless as is possible in a good belt.

We carry stock up to 18 inches in width, and can make good deliveries.

Scandinavia Belting

for direct drives is a very satisfactory and economical belt. Has great strength. Stands up well on shifters.

The original solid woven belt.

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Are you receiving our monthly publication, "Belts"? It is sent free to users of belting, whether they use ours or not. If you are not receiving it, fill out attached coupon.

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If you use material for any of the following purposes, specify DIXON'S the next time you place an order. The price may be a little higher than you have been paying, but you will get more service and more satisfaction for your money. The best is always worth its cost. Inferior goods are usually expensive at any price.

Shipments can be made promptly from Montreal.

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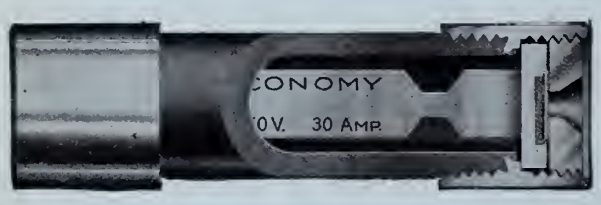
Cut Costs **80** per Cent



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LARGE STOCKS LACO-NITRO LAMPS, STANDARD SIZES 60 TO 1,000 WATTS, NOW AVAILABLE FOR SHIPMENT IN MONTREAL, TORONTO, WINNIPEG, VANCOUVER. ORDER THROUGH YOUR LOCAL DEALER OR

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WE can supply you with high-grade apparatus that has been slightly used and discarded through no fault of its own, at an **immense saving in cost.** For instance, in many cases we take over entire plants simply because of changed conditions such as increased capacity, change of system, etc.

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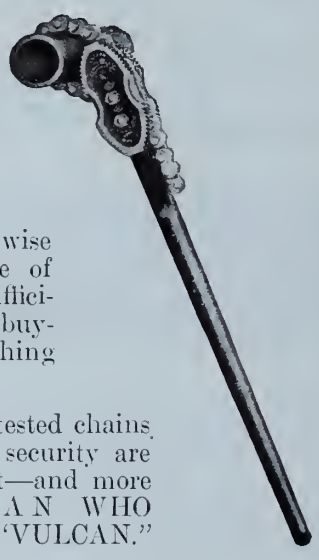
7 sizes, accommodate ⅛″ to 12″ pipe and hold all records for service and the "Grand Prize" for excellence.



Only the penny wise begrudge the price of "V U L C A N" sufficiency. Experienced buyers will take nothing else.

Double life, proof tested chains and knowledge of security are worth all they cost—and more —TO THE MAN WHO KNOWS THE "VULCAN."

The Wrench of 25% Greater Efficiency

TRIMO PIPE WRENCH

Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

The inserted jaw in the handle can be readily replaced when worn, thus adding to the life of the tool.

Nut with Nut-Guards

Inquiries from Importers and Dealers Solicited. Send for Catalogue No. 55.

TRIMONT MANUFACTURING CO.

CableAddress: Triwrench
Code: Western Union

Roxbury (Boston) Mass., U.S.A.

GARLOCK PACKINGS

For General Hydraulic Service

and in steel mills and blast furnaces, where pressures vary by thousands of pounds, and where rams and plungers are often exposed to grit and corrosion

Garlock Style No. 960

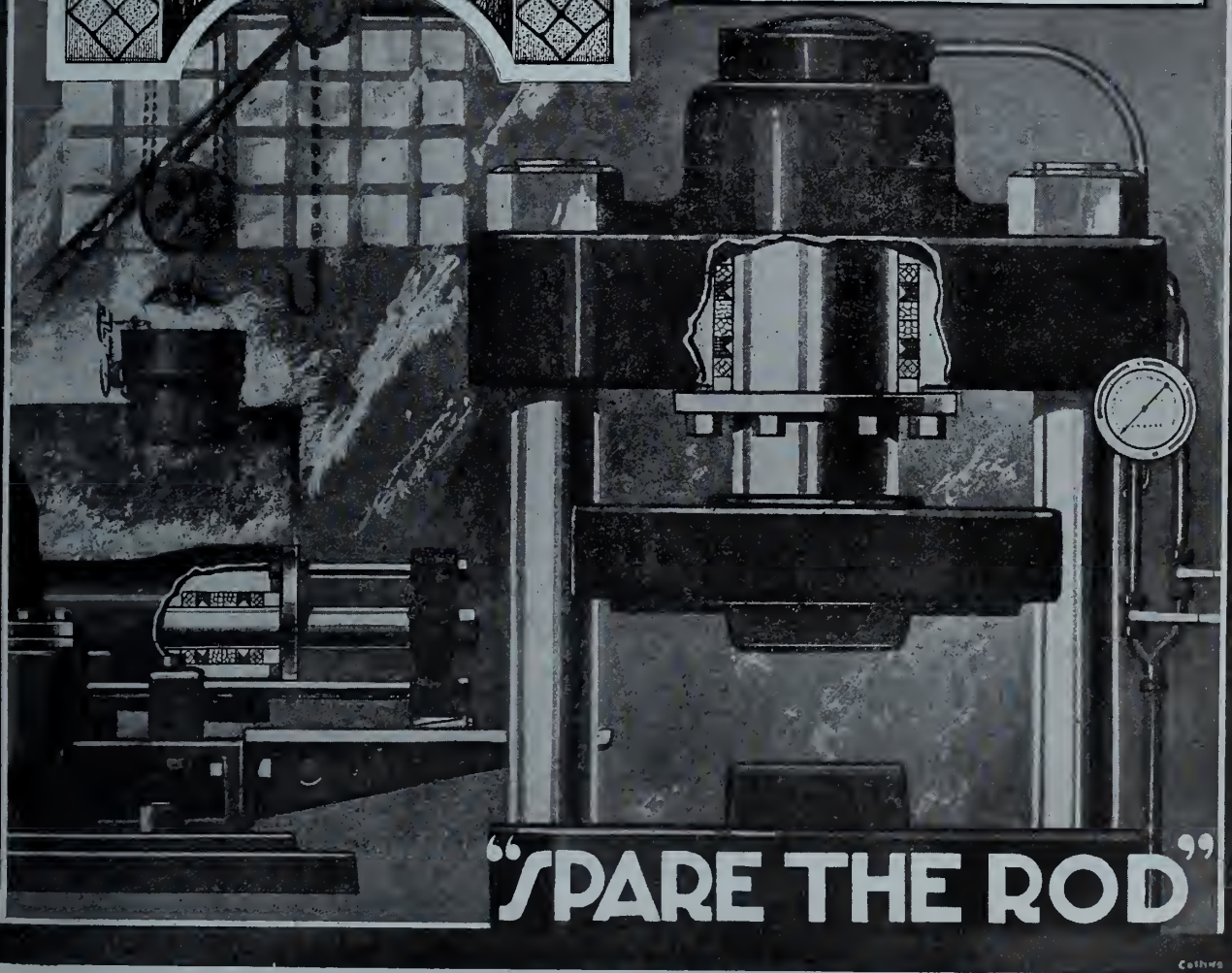
is guaranteed to give entire satisfaction. This combination is made up of braided copper, metal wedge and waterproof hydraulic rings. This will hold a pressure of 3000 pounds.

Write for our catalog.

The Garlock Packing Company
Hamilton, Ont.

BRANCHES:

Montreal, Quebec - - 409 Shaughnessy Building
Toronto, Ontario - 404 Continental Life Building
Winnipeg, Manitoba - - - - - Galt Building



"SPARE THE ROD"

If any advertisement interests you, tear it out now and place with letters to be answered.

6 F TYPE, OIL FILTERING AND CIRCULATING SYSTEM

Conservation of POWER

With the BOWSER ESTABLISHED 1885

Oil Circulating *and* Filtering System

Improper lubrication causes friction.

To overcome friction and carry the power house load, extra power is used.

The Bowser System stops this waste of power by providing an unvarying supply of oil for the bearings at all times.

You can see how Bowser will save for you—save power, save shutdowns, save repairs, add to the life of your machinery, increase your production.

Bowser Engineering Department at your Service

S.F.BOWSER&Co.,Inc.

Sales Offices In all Centers **TORONTO, ONT.** Represented Everywhere

COOL RUNNING EQUIPMENT

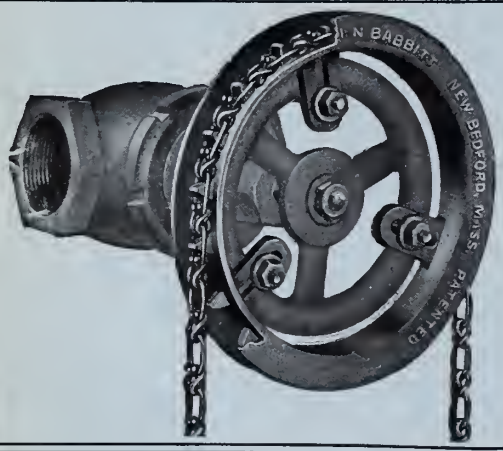
is a matter principally of securing a lubricant that possesses a high lubricating factor and a low melting point. Such a lubricant will never let any bearing become overheated and will assure you of cool running equipment.

ALBANY GREASE

is a pure tallow compound with a high lubricating factor and a low melting point. It can be used on any bearing in your plant and in any kind of grease cup. Send for a trial quantity and an Albany Cup—now.

Albany Lubricating Co.

708-10 Washington Street
NEW YORK



The Ladder Is Always In the Wrong Place And It Has a Habit of Slipping

The Babbitt Adjustable Sprocket Rim

Is SURE To Be In the Right Place and CAN'T Slip

That's the difference between wasting time and saving it—between broken bones and whole ones—between prompt action when promptness means safety, and the delay that spells danger. Nothing like it for opening or closing the out-of-reach valves. The price won't stand in your way for a minute. Ask your dealer. Send us his name and ask for Illustrated Folder.

Babbitt Steam Specialty Co., 59 So. Water Street
NEW BEDFORD, MASS.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

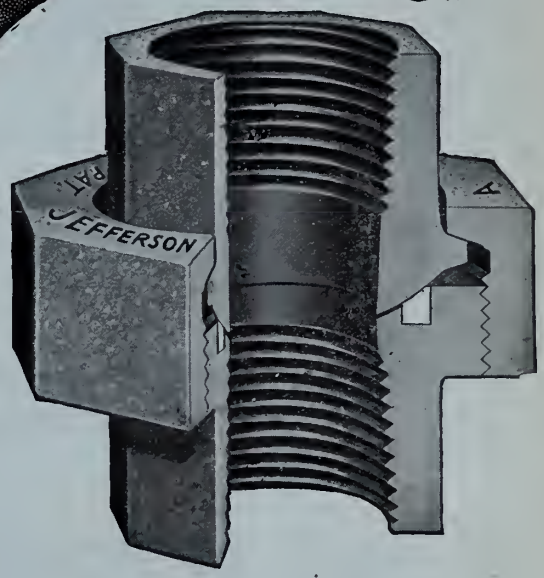
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

Practically Frictionless

In Cotton Tubes



The threads are tapered, insuring strength at pipe ends, and rapid handling

While not as important a feature as the ground ball seat which makes for a permanent tight joint or the patented brass-to-iron joint which prevents corrosion, the fact that

Jefferson Unions

are made with Brigg's Standard Taper Threads, insuring a tight joint throughout the entire length of the threads makes them all the more dependable where tight joints are required.

Then, too, Jeffersons are the heaviest unions of their class made—they'll stand up under more strain and hard service than you would believe possible. And the price is not a disappointment; it is mighty low when everything is considered.

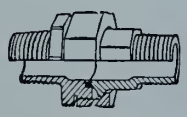
Your jobber has Jeffersons in stock—ask him about them next time you're ordering.

JEFFERSON UNION CO.
LEXINGTON, MASS.

Some Useful Jefferson Union Specials, Some Jefferson Styles

Union Tee, with union on the outlet. Made also with male end on outlet.

Union Elbow, an economizer of the most pronounced type. Also made all female.



All Male Union. Saves two pipe joints between two female threaded parts.

Some Jefferson Features

The ground ball seat which insures a permanent tight joint; the patented brass-to-iron joint which prevents corrosion; the fact that they are the heaviest unions of their class made ,and many other points that make for long, hard service.

Clip the coupon below—fill it out—slip it in an envelope and mail. It'll bring the Jefferson Catalog to you at once.

Jefferson Union Co.
Lexington, Mass , U.S.A.

Please send your book on Jefferson Unions

Name .....

Firm .....

Address .....

P.H.

If any advertisement interests you, tea r it out now and place with letters to be answered.

Power Plant Equipment Company

Steam Boilers, Engines, Specialties,
Water Heaters, Pumps, Piping, Valves
Electric Motors, Generators, Transformers,
Electric Wiring and Installation

We are prepared to quote on your requirements completely installed and running.

L. O. Smith, Manager
Thos. Henry, Electrical Engineer
J. M. Prentiss, Sec'y-Treas.

TRADERS BANK BUILDING Rooms 621-2-3-4 TORONTO

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Read What Prominent Users Say About

Morehead Back to Boiler SYSTEM

It is saving large percentages in fuel bills.

Giving satisfactory service under most difficult conditions

Saved 33% on fuel bills.

Montreal, Sept. 19, 1916.

Gentlemen,—Yours of the 14th inst. at hand. In reference to our Morehead Trap we cannot speak too highly of same; facts will prove more than literature; we really believe that it has saved us 33 per cent. on our fuel bills since we have had it.

We sincerely remain,
Yours truly,
(Sgd.) ROBIN FRERES.

The only system for them

London, Canada, Aug. 5th, 1916.

Dear Sirs,—In reply to yours of August 4th regarding the trapping system, which you installed for us, we are pleased to state that it has been perfectly satisfactory up to the present date and we would not return to our previous system under any consideration.

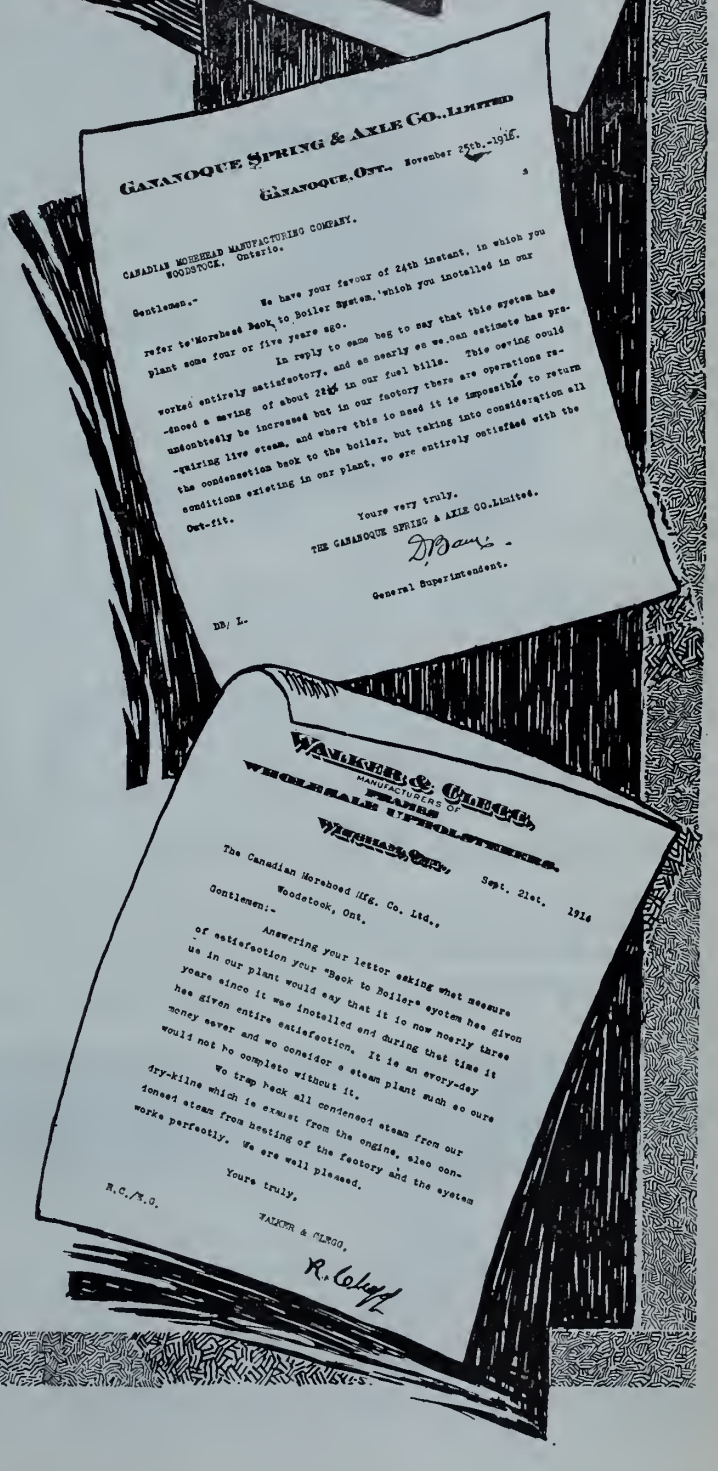
Yours truly,
(Sgd.) GORMAN ECKERT & CO., LTD.

Through a fire— still operating

Hamilton, Ont., September 14th, 1916.
Re Back to Boiler System.

Dear Sirs,—In reply to your favor of the 11th instant, we beg to state that since installing your Morehead Back to Boiler System we have had no complaint whatever from our engineer, although the Trap was in the midst of the hottest part of the fire we had recently in our factory. With the exception of renewing some packing the Trap has performed its duty to our satisfaction, necessitating no repairs whatever, excepting packing as stated.

Yours respectfully,
(Sgd.) LUMSDEN BROS.



GANANOQUE SPRING & AXLE CO., LIMITED

GANANOQUE, ONT., November 25th, 1915.

CANADIAN MOREHEAD MANUFACTURING COMPANY.
WOODSTOCK, Ontario.

Gentlemen.- We have your favour of 24th instant, in which you refer to Morehead Back to Boiler System, which you installed in our plant some four or five years ago.

In reply to same beg to say that this system has worked entirely satisfactory, and as nearly as we can estimate has produced a saving of about 22½ in our fuel bills. This saving could undoubtedly be increased but in our factory there are operations requiring live steam, and where this is used it is impossible to return the condensation back to the boiler, but taking into consideration all conditions existing in our plant, we are entirely satisfied with the Out-fit.

Yours very truly.
THE GANANOQUE SPRING & AXLE CO.Limited.
D Bain
General Superintendent.

DB/ L.

WALKER & CLEGG
MANUFACTURERS OF
WHOLESALE TYPEWRITERS
WINNIPEG, MAN., Sept. 21st, 1916

The Canadian Morehead Mfg. Co. Ltd.,
Woodstock, Ont.

Gentlemen:-

Answering your letter asking what measure of satisfaction your "Back to Boilers" system has given us in our plant would say that it is now nearly three years since it was installed and during that time it has given entire satisfaction. It is an every-day money saver and we consider a steam plant such as ours would not be complete without it.

We trap back all condensed steam from our dry-kilns which is exhaust from the engine, also condensed steam from heating of the factory and the system works perfectly. We are well pleased.

Yours truly,
WALKER & CLEGG,
R. Clegg

R.C./E.G.

Canadian Morehead Manufacturing Company

WOODSTOCK (Dept. A) ONTARIO

COPY June 30th, 1917

Beveridge Paper Co., Limited, Montreal, Que.

***RE* PROTECTO BOILER COMPOUND**

Gentlemen:—Before we used this material our Boiler had scales on it, in some places ¼" thick and although we have used PROTECTO for only about one month and a half, our Boiler now has a good deal less scale, and in our opinion, it will only be a matter of a short time until it will be entirely free from all scale.

It is now a noticeable difference in the amount of fuel which we consume, and we would not want to be without PROTECTO.

We are enclosing herewith a few samples of the scale which PROTECTO has removed from our Boilers, we think you will be interested in seeing this.

You may use our name as recommending PROTECTO for Boilers.

Yours very truly, ST. CATHARINES SILK MILLS LTD.
(Signed) H. C. Specht, Pres.-Treas.

REPRESENTATIVES:

J. M. ALLEN, - 65 Bloor Street West, TORONTO, ONT. WM. REID - - 27 Celebration Street, ST. JOHN, N.B.
P. H. COWAN & CO. - - - ST. JOHN'S, NFLD.

HOMESTEAD

Quarter-turn *Valve*

RENDERS

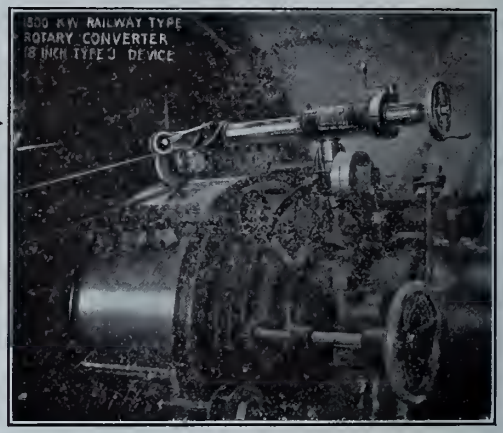
Continuously Efficient Service

Simple, yet containing many features that single it out as one that would be the safest and most efficient to adopt.

Tightness is made certain by patented wedging cam that automatically forces plug downward in closing and instantly releases it again when handle is turned to open valve. The plug is always held in perfect balance. Quick opening by quarter turn of handle. Straight-way, three-way or four-way patterns. We have a valuable article here. Send us your address

Homestead Valve Mfg. Co.

Works: Homestead, Pa. Pittsburgh, Pa.



COMMUTATOR TRUING DEVICE

Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

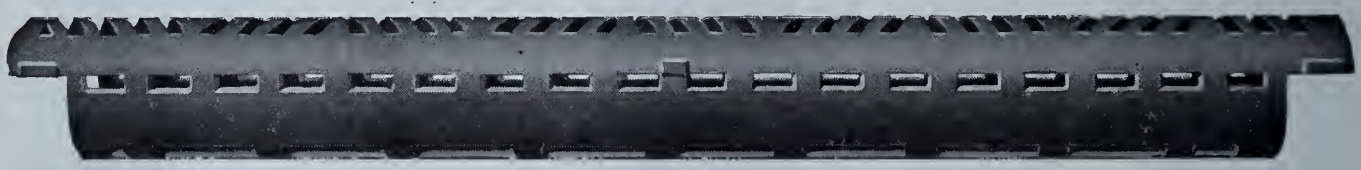
Jordan Bros., Inc.

82 Beekman St. New York City, N.Y.

Canadian Representative:
CANADA SALES CO., 183 Church Street, Toronto, Canada

THOMAS ELLIPTIC GRATE BARS—

SHAKING
CIRCLE
STATIONARY



Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of paying for themselves in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

CANADIAN Sirocco COMPANY LIMITED

WINDSOR. ONTARIO.

SALES OFFICES:

Canadian Sirocco Co., 526 Traders Bank Bldg., Toronto. Phone Main 5118.
A. M. Nichol, McGill Bldg., Montreal.
S. S. Clarke, 605 W. Second St., Calgary.
W. W. Hicks, 567 Banning St., Winnipeg.
Canadian Sirocco Co., Ltd., 604 Credit Foncier Bldg., Vancouver.

CURTIS Engineering Specialties

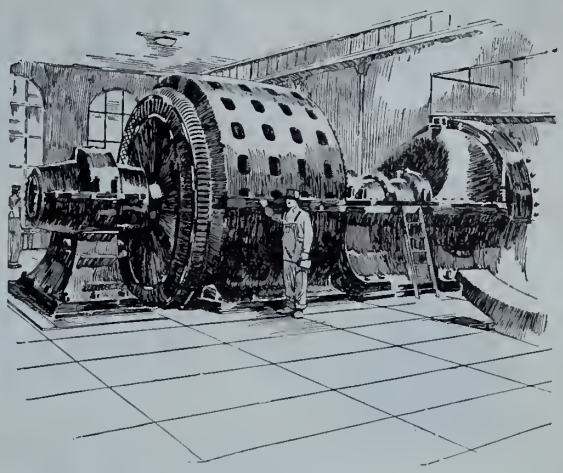
CURTIS Water Pressure Regulator

The Economy of this Curtis Water Pressure Regulator (See Illustration) lies in the fact that it greatly reduces the cost of keeping plumbing in order — This by obviating the wear and tear of water hammer or concussion in pipes.

This regulator is warranted to maintain the pressure desired, with perfect uniformity, regardless of any fluctuations of outside pressure. The workmanship and material of the Regulator cannot be excelled. Trouble from rust or clogging is entirely avoided. Delivery of water into service pipes at any desired pressure is guaranteed.

Send for special leaflet and price list to the manufacturers.

JULIAN D'ESTE COMPANY
26 Canal Street, BOSTON, MASS.



What Do Your Floors Cost?

WE don't ask what they are *worth*—we ask how much they cost you in lost time, cost of maintenance and damaged machinery.

—Perhaps it has never occurred to you that unprotected cement floors may be the cause of your machinery trouble. Perhaps you never realized that the fine, gritty dust from the floors is what makes your bearings run hot and your dynamos and motors to spark.

R.I.W. REMEMBER ITS WATERPROOF REG. U.S. PAT. OFF. CEMENT FILLER & CEMENT FLOOR PAINT PATENTED AS TO PORTLAND CEMENT FEB 27 1906

will make your floors durable, dustless and cheaper to maintain. Oil, water and acids cannot soak into and soften the cement because the surface is scientifically sealed.

Floors treated with R. I. W. Cement Filler and Cement Floor Paint will not crack or disintegrate and will give longer, cheaper and more satisfactory service all around.

They are specified by experts the world over.

Write for descriptive literature, Dept. 59.

TOCH BROTHERS
Technical and Scientific Paint Makers Since 1848
320 Fifth Avenue, New York
Works: New York; London, Eng.; Toronto, Canada

R.I.W. REMEMBER ITS WATERPROOF
STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!
REG. U.S. PAT. OFF.

If any advertisement interests you, tear it out now and place with letters to be answered.

VALVES

BRASS
OR
IRON BODY
SCREWED
OR
FLANGED

Suitable
FOR
STEAM,
WATER,
GAS,
AIR,
ACID or
OIL

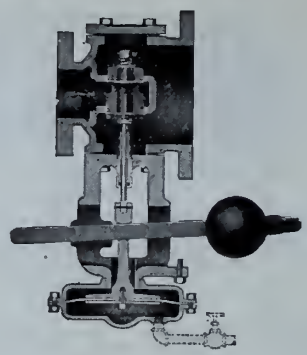
Sizes
¼" to 12"
Carried
in Stock

For
Pressures
125 to
500 lbs.

GLOBE, ANGLE, CHECK and GATE.

T. McAVITY & SONS
LIMITED
Hardware and Metal Merchants
Brass and Iron Founders
ST. JOHN, N.B.

MONTREAL, TORONTO, WINNIPEG
LONDON, ENGLAND



SPECIAL 98
VACUUM PRESSURE
REGULATING VALVE
THERE IS A

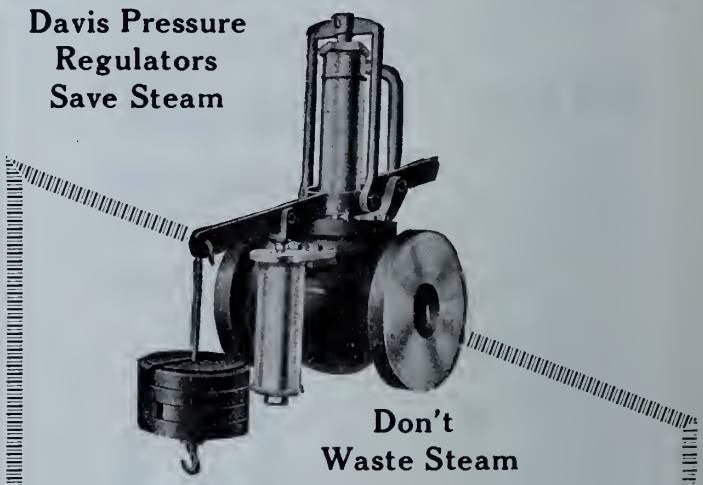
Kieley & Mueller

Regulating Valve for Every Service

The valve illustrated above is specially designed for use with vacuum or vapor heating systems—initial pressure 150 lbs. or less—reduced pressure 0 to 10 lbs.

SALES ENGINEERS
THE ARTHUR S. LEITCH CO.
TORONTO

Davis Pressure Regulators Save Steam



Don't Waste Steam

You carry high boiler pressure for emergencies and peak loads, but are you sure this reserve is not slipping away? You know only too well the cost of coal—conserve it by keeping your steam pressure under full control with

DAVIS PRESSURE REGULATORS

Put these automatic valves to work wherever you can use less than boiler pressure. The cost is trifling and the saving big. Forty years on the market is enough to prove they are built right. Send for catalog. It will show you a way to cut costs.

G. M. DAVIS REGULATOR CO.
434 Milwaukee Avenue
Chicago - - - Illinois

TRADE JENKINS MARK
Jenkins Bros.

JENKINS BROS.'

TYPE "K"

BRASS GATE VALVES

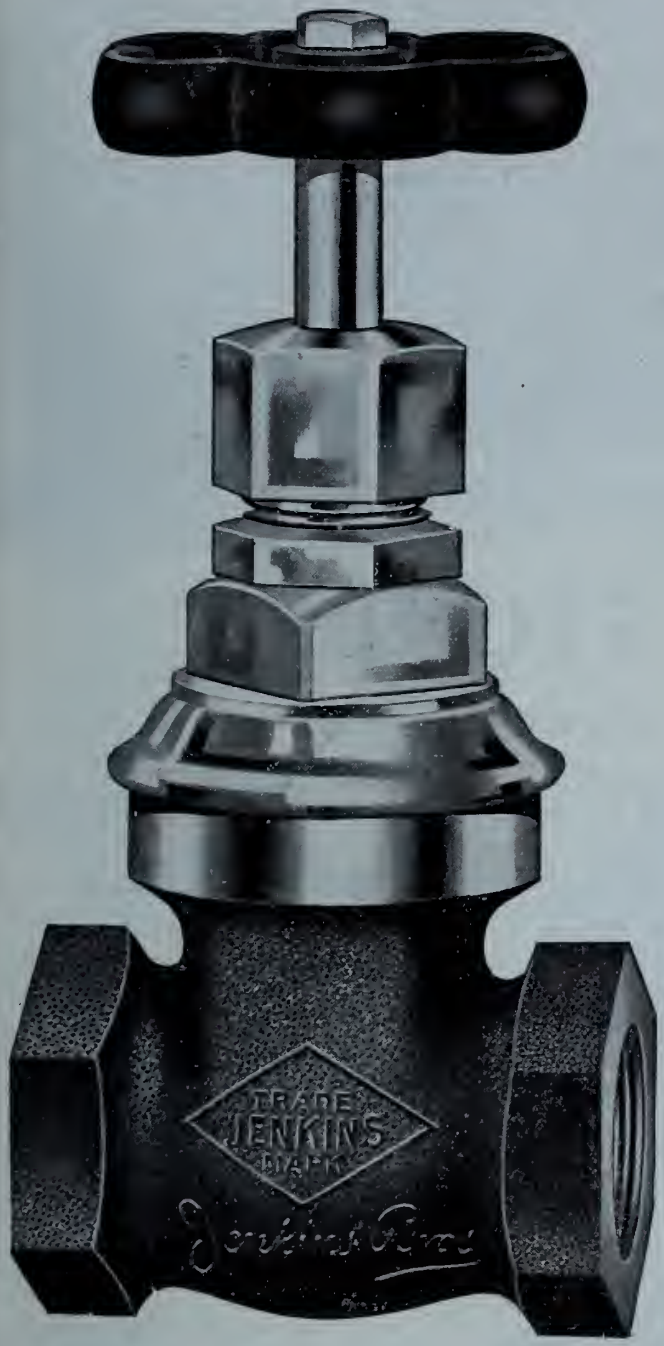


Fig. 300
TYPE "K" BRASS GATE VALVE SCREWED

Type "K" Brass Gate Valves

are different from ordinary Gate Valves because they are made from the best grade of metals in a modern factory under expert supervision.

Particular attention is paid to every detail in their manufacture, and before they are delivered for shipment every valve is carefully inspected and thoroughly tested under working conditions by both steam and hydraulic pressure.

Type "K" Brass Gate Valves carry the usual JENKINS BROS.' guarantee of Service and Satisfaction.

Your dealer will supply you.

Catalogue No. 8 sent free on request.

TRADE JENKINS MARK Jenkins Bros.

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros.

103 ST. REMI ST. MONTREAL

If any advertisement interests you, tear it out now and place with letters to be answered.

MURPHY STOKERS

as installed in the Power Plant of

CANADIAN KODAK COMPANY, Limited, TORONTO, ONT.

The Canadian Kodak Co. has had 8½ *years' experience* with Murphy Stokers, and the parent Company (Eastman Kodak Co., Kodak Park, Rochester, N.Y), 10½ *years' experience.* The two corporations executed 7 *contracts*—30 stokers, 9,400 H.P.

REPEAT ORDERS; is the best evidence of merit in any device!

For the year 1916 we received REPEAT ORDERS from 63 leading industrial firms and corporations in the United States and Canada, for 154 *Murphy Stokers*—46,623 nominal H.P.; the 63 firms and corporations have executed 299 *contracts* covering 769 *Murphy Stokers*—299,825 H.P.

For January, February, March and April, 1917—

31 *REPEAT ORDERS,* 74 *STOKERS*.....24,800 *H.P.*

For catalogue Address

MURPHY IRON WORKS

DETROIT, MICH., or BUFFALO, N.Y.

The GOLD MEDAL FURNITURE MANUFACTURING CO. LIMITED.
WHOLESALE FURNITURE MANUFACTURERS
DEALERS AND IMPORTERS OF FURNITURE COVERINGS UPHOLSTERERS AND MATTRESS SUPPLIES
TORONTO, CAN.
October 4, 1915.
William B. Pierce Co.,
Buffalo, New York.
re: DEAN CLEANER.
Gentlemen:
I wish to say that since using the DEAN, I have effected a great saving in fuel.
Previous to its use, I burned the best R.O.M. coal—now I burn screenings and only a little more than half the quantity, at the same time developing about 15 H.P. more than before.
I think that if the DEAN CLEANER was better known to engineers in Canada, they would not care to be without it. I would willingly demonstrate its good points to any engineer who might have any doubt about it—
BUT—I could not show results, as I have no scale on the boilers to come off.
Yours very truly,
Engineer.

—since using the DEAN I have effected a great saving in fuel

Every engineer knows that clean boiler tubes mean better steaming. But not every one can be convinced that if he keeps his tubes free from ALL scale, he can frequently, by experimenting use cheaper fuel—and still develop the same, or greater, horsepower.

Mr. Farrow used to burn the best run-of-mine coal. His employers thought the coal bills were too high It seemed that substantial economies could be effected. So, a Dean Boiler Tube Cleaner was installed on trial.

(See Mr. Farrow's letter above for statement of results).

We do not advance the argument that you can use the Dean Cleaner and equal Mr. Farrow's results. Possibly you have already solved this problem. But, we do believe that if you used the Dean, it would produce surprising results and be a valuable addition to your plant.

The great secret of the Dean Cleaner's success lies in the fact that it does not leave a particle of scale in the boiler, as so many other cleaners do, but removes it ALL, thus bringing into the most direct contact the heat and water.

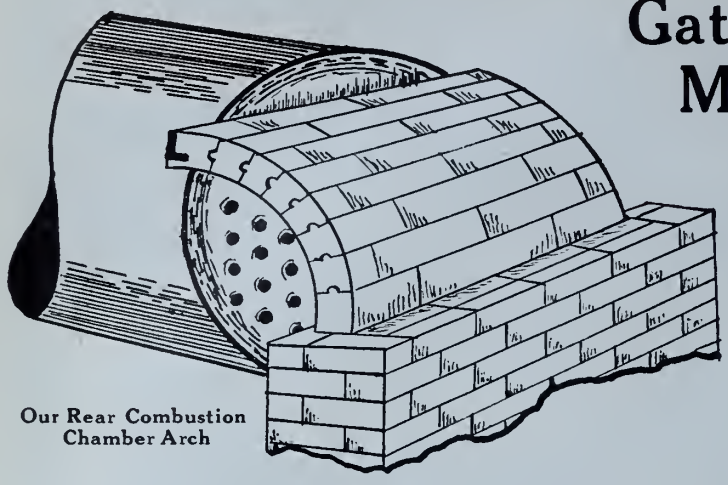
A request for description of the Dean Cleaner will bring a prompt response, including details of free trial offer.

The William B. Pierce Company

Franklin Building, Buffalo, N.Y.

W. W. Hicks, 567 Banning St., Winnipeg, Man.
Francis Hankin & Co., 201 Coristine Bldg., Montreal, Que.

If any advertisement interests you, tear it out now and place with letters to be answered.



Our Rear Combustion Chamber Arch

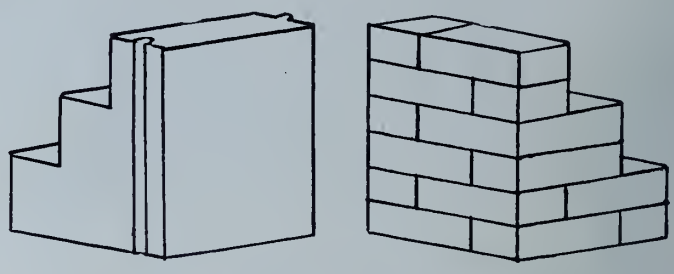
Gates Fire-Brick Blocks More Durable and More Efficient Than the Ordinary Fire Bricks

They form a much thicker wall around the fire, thus conserving the heat and reducing fuel bills. Number of joints in furnace wall open to attack of deteriorating influences greatly reduced, ensuring long life.

Air-Proof Firebox Lining

Clinkers do not readily form on their smooth and even surface, and the tongued and grooved joints prevent air leaks, making the firebox perfectly air-tight. Thus the lining not only lasts longer, but tends to promote better combustion. They can be readily removed and replaced without disturbing the surrounding brickwork, a feature not to be found in any other Block.

We manufacture: Boiler Door Arch Blocks, Boiler Door Jamb Blocks, Rear Combustion Chamber and Firebox Blocks. We also contract for and specialize in: Boiler Setting, Furnace Building, Oven Work, and all kinds of Power Plant Brick Work.



Three Chances to One in Favor of Gates

Add the number of inches of joints in the piece of brickwork at the right and compare with the number in our solid block at the left. The brickwork has more than three times as many. That means three times as many chances for the heat to attack the body of the brick and bring your firebox lining to a quick end. The material in our block is more durable than that found in ordinary firebrick.

Write for Catalog

JOHN W. GATES

382 St. James St., MONTREAL, Can.

It may never happen to you—but are you SURE it WON'T?

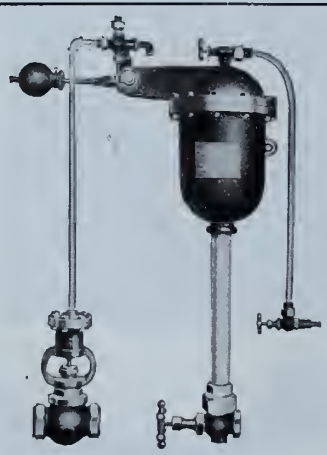
Accidents due to high and low water are occurring continually. Your plant may never suffer, but have you assurance that it won't? Have you taken the necessary precautions against this danger?

The Vigilant Feed Water Regulator is guaranteed to keep water level within ¼" of middle gauge. It is a positive prevention of dangers arising from high or low water.

Investigate it to-day!

The Chaplin-Fulton Manufacturing Company

28 Penn Avenue - - Pittsburgh, Pa.



Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

Regulating Valve Placed at Any Point, Any Position.

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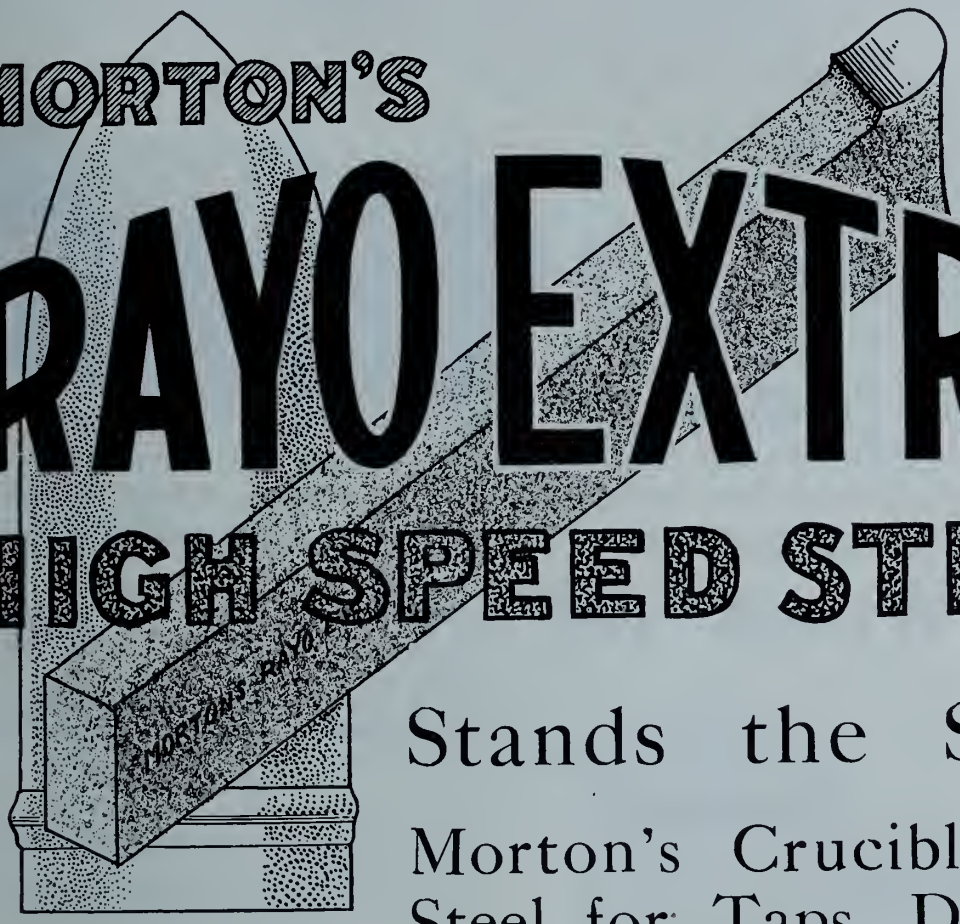

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This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs.* Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

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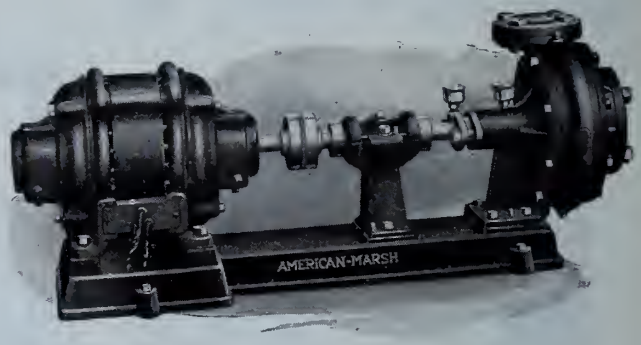

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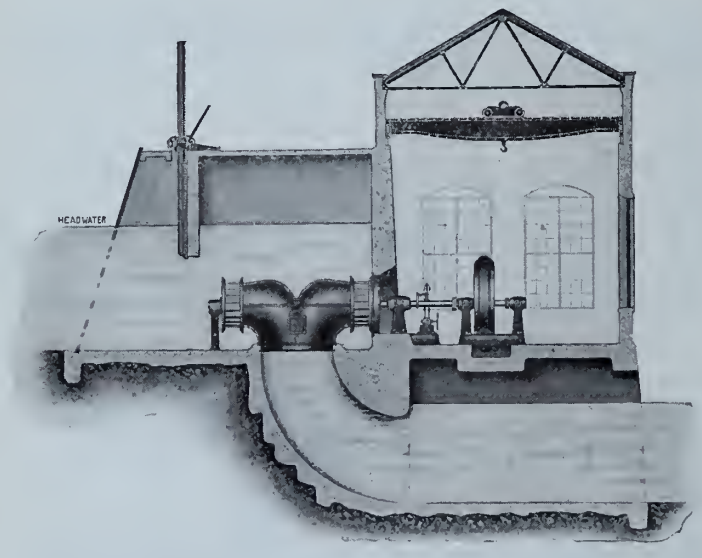

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(a) To serve as a school of instruction for its members;

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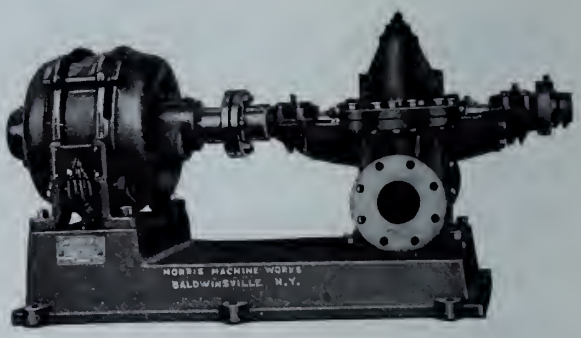

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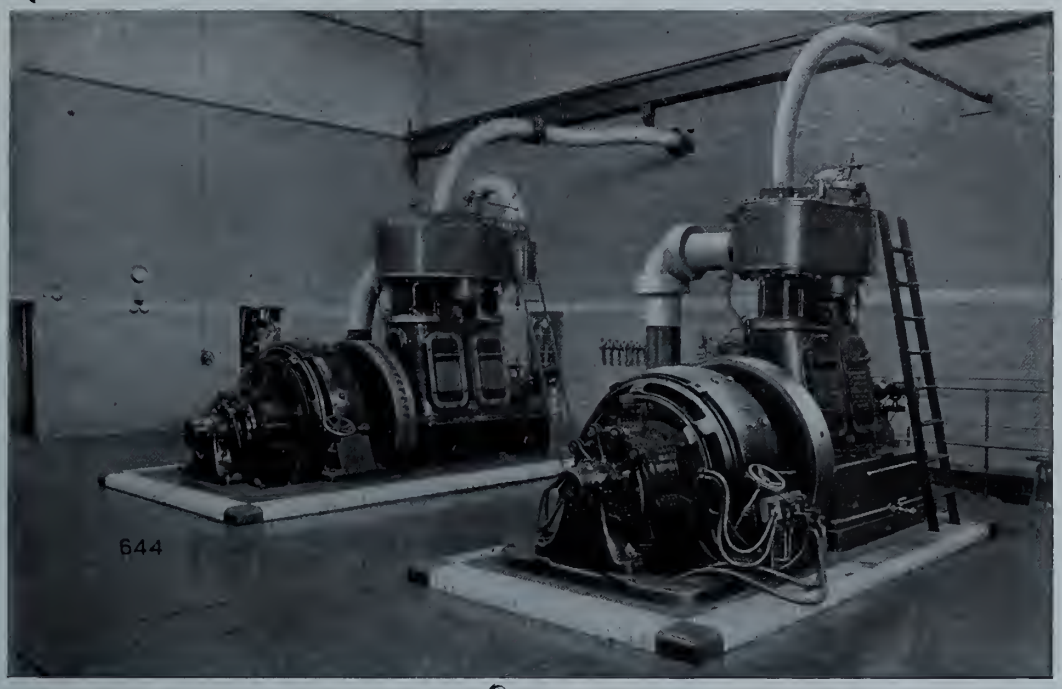

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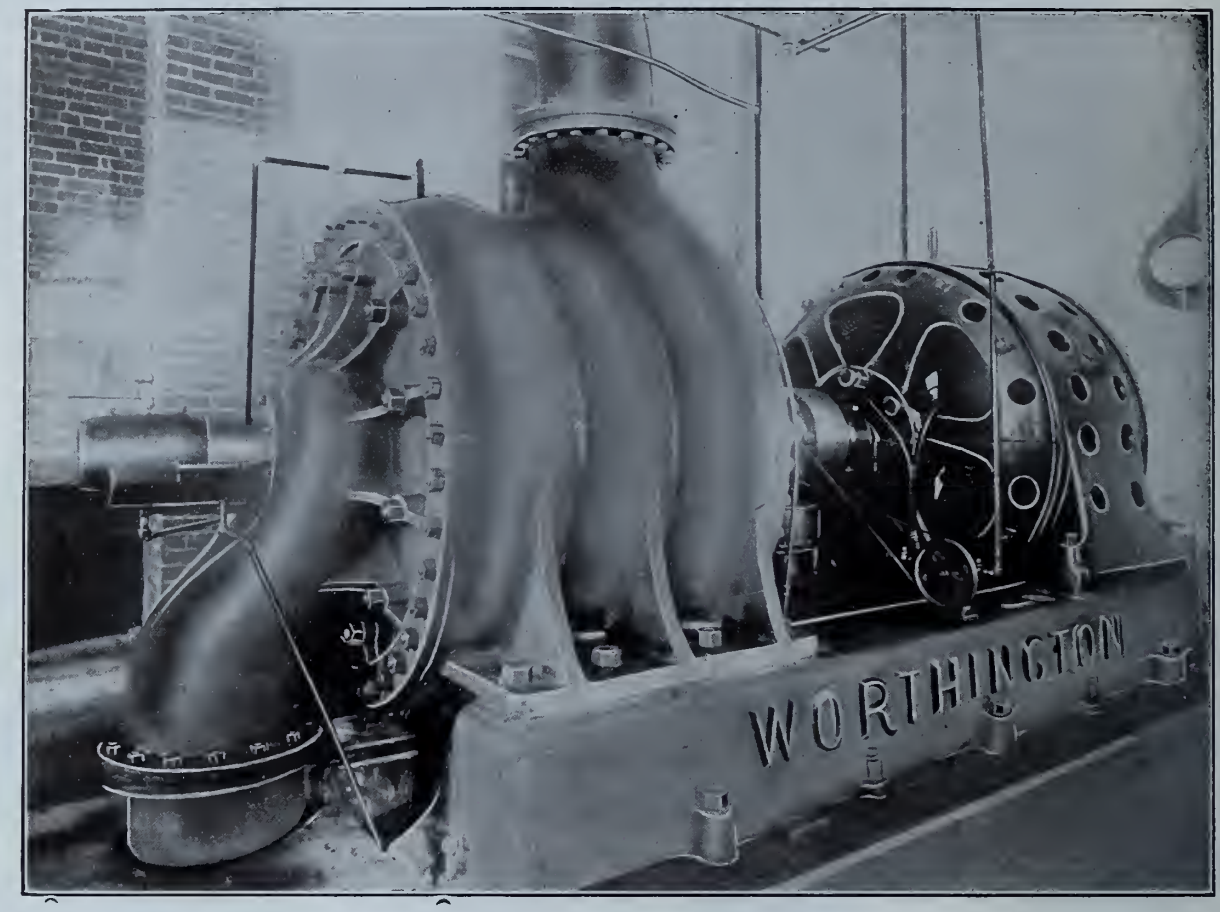

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The Publisher's Page

TORONTO July, 1917

Important Announcement

AS was intimated in our June issue, Graded Certificates will in the near future be in force in the Province of Ontario. Just how soon the regulations will go into effect is a matter that will be determined by the Government, but sooner or later Ontario engineers will be required to write their examinations.

Beginning in this issue of POWER HOUSE there will appear a series of Questions which engineers will have to answer. They are substantially the same as the questions which will be used in connection with the coming Graded Certificate Examinations. Their answers will be given in POWER HOUSE and any engineer who will study the series of Questions and Answers cannot fail to be greatly benefited.

And what is good for those who may have to try their examinations will also be found good for those who do not have to qualify and it will be found equally beneficial by those who have already qualified.

This number of POWER HOUSE, aside from the initial installment of the Questions and Answers Series, is well worth preserving. It is full of valuable information and deserves the careful study we feel sure it will receive.

Our Editor, Mr. Bain, has provided an exceptionally large and interesting bill of fare editorially while the advertising sections are most instructive, containing as they do the messages of many of the leading manufacturers of power equipment and supplies.

In anticipation of a heavy demand for our July issue we printed an extra supply and new subscribers may commence their subscriptions so as to receive this issue.

THE POWER HOUSE
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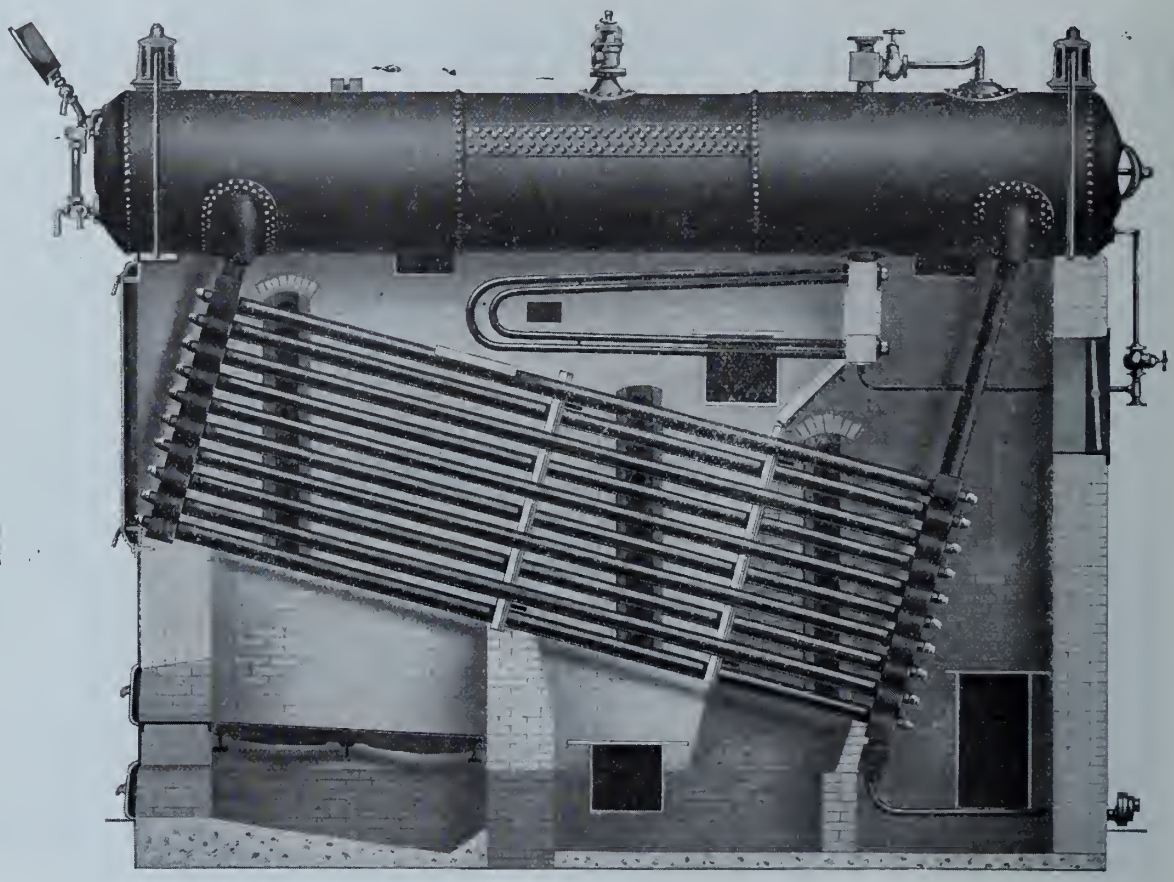

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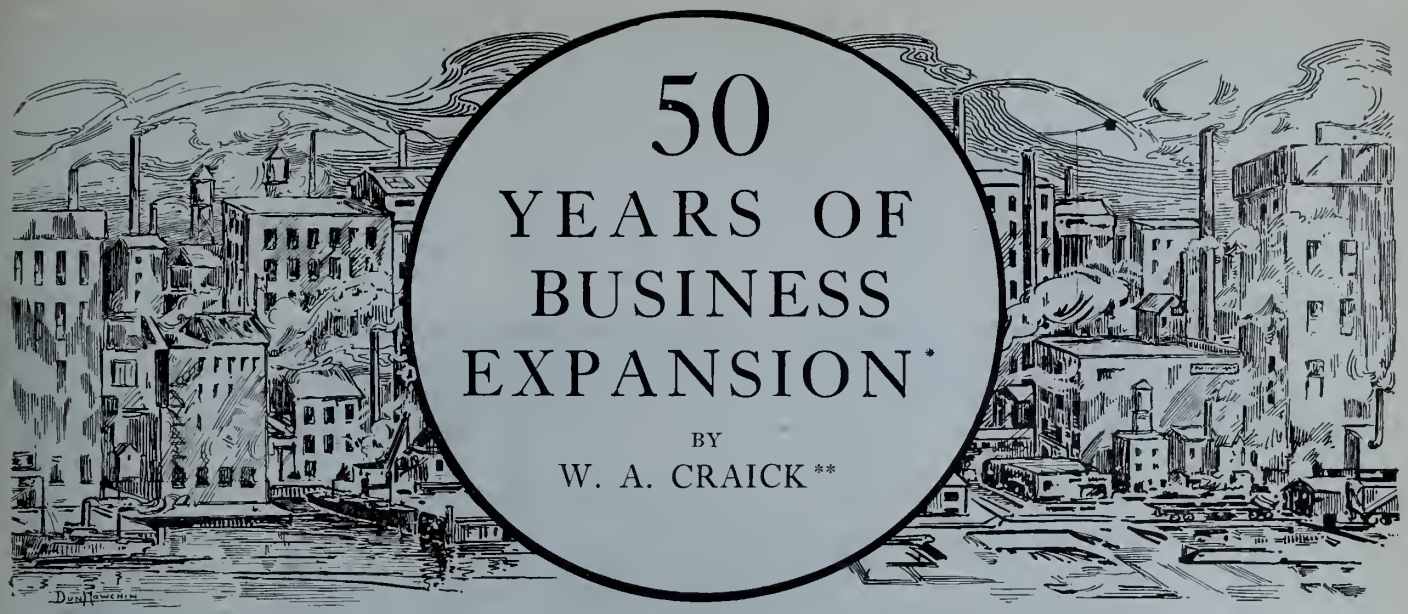


50 YEARS OF BUSINESS EXPANSION*

BY

W. A. CRAICK**

There is here given in racy fashion, yet evidencing in the variety detail discussed considerable painstaking and scrupulous regard for developments in the period under review, to the end that as far as possible everything embraced by the article title, wide in scope as it happens to be, should get at least a passing reference. Speaking generally, the advances made in the spheres of Industry, Finance, Transportation and Insurance are prominently featured.

CANADA'S position at the close of the fiftieth year of Confederation is imposing only in so far as present day conditions are placed in contrast with those prevailing at the dawn of the Confederation era. Progress is at best a relative term, and to appreciate to the full the extent of this country's development, one must visualize the setting in which that development was commenced.

To all intents and purposes, the whole of Western Canada, with its far-flung population, its many fine cities, its thousands of miles of railway and its enormous agricultural production, must be eliminated from the canvas. It is true that by 1867 some ten thousand people had settled in the Red River Valley; that stragglers had penetrated even farther west. It is also true that the gold rush of the late fifties had poured population into the Fraser River Valley and that Victoria was already a fair-sized town. But these widely-separated settlements, on the prairies and at the Coast, were almost as distant from Eastern Canada in those days as Australia is to-day, and further, their business associations were entirely with the neighboring sections of the United States.

Canada in 1867

The picture of Canada in 1867 narrows, therefore, to the comparatively restricted limits to the older settled portions of the country—the narrow fringe of clearing along the St. Lawrence; the lake front counties of Ontario; the coast and river settlements of New Brunswick and the scattered towns and fishing villages of Nova Scotia. The wider vision of a great and prosperous West had not yet seized upon the minds of the people and their field of possible endeavor lay no further off than the thickly wooded concessions of the back counties.

Though fairly well populated and supplied with the modern means of communication, the older sections of Quebec and Ontario were still in a comparatively crude and undeveloped condition. Even between Montreal and Toronto, then as now, the two foremost centres of population in Canada, the appearance of the country was anything but prepossessing. There remained much uncleared land. Many of the homes of the inhabitants were at best but miserable shanties. The people were poor; the children dirty and ragged; the cattle lean. Towns, which were quite as numerous as they are to-day, and in several cases nearly as large, were suffering from the after-effects of the Grand Trunk boom, and exhibited numerous unoccupied and delapidated buildings.

From Prescott to Ottawa, then the customary route to the Capital, the railway traversed what appeared to be a continuous pine swamp, wet, dismal and depressing. The Capital itself lay hidden away in the midst of green, unbroken forests, which closed in on the log houses and small villas lying on the outskirts of the embryo city.

To the rear of the counties fronting on the St. Lawrence and Lake Ontario, settlement was just getting under way at the time Confederation came into being. Railways were being promoted to tap the resources of Peterboro, Victoria, Simcoe, Grey and Bruce Counties, and settlers were arriving from the Old Country to people their solitudes. In fact, this particular section of Canada was going through an experience which has since been duplicated many times in the West.

The Government was devoting special attention to the settlement of the free grant lands in the Muskoka District. Advertising matter of the same brand as that which later lured thousands of immigrants to the prairies, told of the prospective wealth to be derived from the cutivation of the soil in this remote part of the province. In response to the appeal, population was penetrating as far north as Parry Sound on the shore of the Georgian Bay, while Bracebridge was thronged with newcomers.

Oil and Gold Booms

It was about this period, too, that the oil boom in Enniskillen Township and the gold boom at Madoc were absorbing public attention. The former attracted the curious from all parts of the country. To reach the oil fields, visitors had to leave the Sarnia branch of the Great Western at Wyoming and drive through the woods to Oil Springs. It was a trip, as described by travelers, full of spectacular interest. The great dark forest, traversed by a narrow plank road; the constant succession of carts coming and going with their barrels of oil; the derricks, oil tanks and engines scattered through the clearings, all presented a scene of strange and outlandish character. Oil Springs itself was a village of wooden hotels, thronged with speculators and hangers-on, who by their frenzied efforts to secure paying properties increased the popular interest in the district.

The Madoc gold finds were made in the year before Confederation and the rush to the mines in the spring of 1867 was one of the events of that momentous year. Prospectors in large numbers thronged to the new gold fields, from which so much was expected, and many miners, who had participated in the California and British Columbia rushes, made their way to the new Eldorado. Five lines of stages from Belleville to Madoc

*Also in MacLean's Magazine.
**Of MacLean Publishing Co. Staff.

were for a time insufficient to accommodate the crowd who sought access to the scene of the discovery.

These events, bulking largely in the popular imagination at the time, have long since dwindled into their proper proportions. The oil wells of Enniskillen have become a commonplace; the gold strikes at Madoc have sunk into insignificance. Reference has been made to them merely to illustrate how places which fifty years ago were on the very fringe of settlement and to reach which tedious journeys had to be made, are now left far in the rear by the tide of progress. The gold of Porcupine has long since eclipsed the gold of Madoc, and in Southern Alberta the oil prospector has been finding new fields for his investigations.

Lumbering

In various other respects conditions have changed in old Ontario and Quebec. Lumbering was a far more important industry fifty years ago than it is to-day. The Great Western Railway brought down from its Sarnia branch annually large quantities of oak timber. This wood was rafted at Hamilton and towed to Quebec for export to the Old Country. The Northern Railway carried to Toronto, and the Port Hope, Lindsay and Beaverton Railway hauled to Port Hope trainload after trainload of lumber for shipment by schooner across the lake. Cordwood was one of the commonest commodities of the day, and trainloads of it were a common sight on the railroads fifty years ago. It was used not only for heating and cooking, but it formed the universal fuel for locomotives, and from the back settlements thousands of cords were shipped annually to the United States.

LUMBERING ON THE UPPER OTTAWA. A FLOURISHING INDUSTRY AT THE TIME OF CONFEDERATION.

Early City Settlements

The extent of settlement in 1867 was reflected in the cities. To-day there are in the Dominion six cities with populations in excess of 100,000 — Montreal, Toronto, Winnipeg, Ottawa, Hamilton, and Quebec—while a seventh, Vancouver, falls little short of that figure. In the year of Confederation, however, Montreal was the only urban centre that came within 50,000 of reaching the 100,000 mark. Toronto could not boast 50,000 inhabitants. Winnipeg was a mere hamlet. Ottawa contained but 15,000 people. Hamilton just exceeded 20,000 by a narrow margin. As for those flourishing Western cities—Calgary, Edmonton, Regina, Saskatoon, Brandon, Moose Jaw, and Vancouver—they were practically all non-existent. Only conservative old burgs like Quebec, Halifax, and St. John, had populations in any way commensurable with present figures.

Our Capital City

The beautiful capital city of the Dominion, whose natural charms have been greatly enhanced by the work of the Ottawa Improvement Commission, has developed during the fifty years of Confederation from a crude backwoods settlement into one of the finest cities in America. So unprepossessing was its appearance when it was selected by Queen Victoria to be the seat of government, that it was described as the Cinderella of Canadian Cities. Its intrinsic beauty was recognized, but that beauty was so hidden by uncouth and dirty surroundings that the comparison was by no means inapt.

Curious visitors who went to view the new capital during the early sixties, came away with mixed impressions. It was admitted that the site of the Parliament Buildings was a lovely one; that the surrounding forests had a wild impressiveness, and that the clear air, everlasting resounding with the noise of falling water, was exhilarating, but what were these natural attractions when everyday living conditions were so bad? The streets were rough, the houses mean and squalid, the hotel accommodation wretched, and the food poor. Lumber and sawdust littered the place until it looked like one vast timber yard.

A sister of Lord Monck, who visited the town shortly before the Governor-General moved there from Quebec, groaned over the prospects of life in such a place, describing it as "t'other end of nowhere." And it is known that civil service employees, who had to forsake the comparative loveliness of Toronto, Montreal, or Quebec, for its early crudities, bemoaned their fate, while Ministers of the Crown took the earliest opportunity to escape from its impenetrable dullness.

Of course, all this has changed. Ottawa to-day boasts the possession of every modern facility, not only for the enjoyment, but for the improvement of life. Its beautiful streets and parks, its splendid public buildings, its superior hotels—all these combine to render the contrast with the miserable, down-at-the-heel settlement of fifty years ago most striking and complete.

And what of other cities? Montreal,

the foremost city of the Dominion with its more than 600,000 people could, in 1867, muster barely one-sixth of that number. In extent it was very considerably smaller. Its principal business thoroughfare of to-day, St. Catherine Street, lay on the outskirts of the city. Even lordly St. James Street, with its splendid financial institutions, was only just in course of construction. Business centred in Notre Dame Street; McGill College stood out in the suburbs, and it was a mile walk from the edge of the city to the mountain.

In several respects, Montreal, fifty years ago, was greatly inferior to the present city. Its streets were notoriously filthy, especially along the docks where the mud frequently lay knee-deep. The lighting even of the main thoroughfares was inadequate, gas being then the universal illuminant. The drainage was bad, and in this connection one visitor tells of having to leave the Theatre Royal one night in the middle of an amusing comedy on account of the vile odors that were wafted in through the windows. Apart from these deficiencies, however, the city seems to have been an imposing place with its solid-looking buildings, its many fine churches and its active commerce.

Our Queen City

Toronto's expansion during the fifty years has been equally, even if not more, phenomenal. When it is recalled that in 1867 Queen's Park, now in the heart of the city, was on its extreme northern edge, Trinity College was situated a mile beyond the western limits and that troops were able to go through extensive evolutions on a great common that lay between the city and Spadina Avenue, some faint conception of the physical growth of the place can be obtained. In population it has increased twelve-fold, or roughly from 40,000 to 480,000.

The cities in the east, Halifax and St. John, have probably exhibited fewer changes than their western sisters. Halifax, which has now about 50,000 inhabitants, had a population of 30,000 at the time of Confederation. St. John, which to-day contains approximately 54,000 people, was then a place of 35,000 inhabitants. In Halifax the lives of the citizens revolved around the garrison of British regulars which manned its forts and citadel. Some trading, it is true, went on with the West Indies. Fish was exported; sugar and other tropical products imported. But the military and naval interests of the place predominated and trade and commerce, while a necessary evil, were not allowed to thrust themselves too far into the foreground.

The commercial spirit was more in evidence in St. John, a city which then as now regarded its Nova Scotia contemporary with a feeling of suspicion and rivalry. St. John had been a notable shipbuilding centre for years and, not only was many a stout vessel built each year in its shipyards, but its merchants owned and outfitted numerous deep sea craft for service on the seven seas. The docks of St. John were a busy spot in those days, for ships and sailors were numerous and there was a constant coming and going of vessels from distant ports.

Industries Feature

If cities were small fifty years ago, so also were the industries that flourished in them. Industrially, there has been a remarkable change in Canada during the past half-century. When Confederation came into being the settled sections of the country were plentifully supplied with an immense number of small steel industries. Each town, each village, had its little group of manufacturing establishments which produced the essentials of life for the people of the immediate neighborhood. A flour and grist mill, a sawmill, a tannery, a carding and fulling mill, a carriage factory and not infrequently a brewery or distillery were the possession of practically every centre of population.

The census of 1861 showed that in Ontario alone there were in operation 501 flour and grist mills, 1,164 sawmills, 271 tanneries, 185 carriage factories, and 143 breweries and distilleries. In Ontario, Quebec, New Brunswick, Nova Scotia and Prince Edward Island combined, there were 8,503 industries, of which 1,785 were flour and grist mills, 4,240 sawmills, and 710 tanneries. By 1867 all these figures had probably been considerably increased.

Few of these primitive local industries have survived the evolution of the centralized factory system. Here and there through the country there may remain some pathetic examples of these once important institutions. But, generally speaking, the economies introduced in the operation of the large factories of to-day have made it quite impossible for the small industry to exist.

Lachine Canal an Industrial Factor

Even in the sixties there were evidences of the development of large-scale manufacturing. The building of the Lachine Canal seems to have produced a considerable industrial boom in Montreal. The canal furnished four million horsepower of hydraulic energy per annum, a huge figure for those days, and, as practically all manufacturing was done by waterpower, manufacturers naturally flocked to this new source of energy.

The extent and importance of the factories along the canal filled visitors with astonishment. There were huge iron works, employing no fewer than 120 men and producing 12 tons of nail plates per day! There was a wonderful new flour mill, which could grind 500 bbls. of flour in twenty-four hours. There was a sugar refinery with a capacity adequate to manufacture seven-eighths of the sugar consumed in Canada and there was a marine works, which could produce several ships for river and lake service each season.

One may smile at the expressions of amazement with which the citizens of 1867 regarded these examples of industrial enterprise, the size and output of which have long since been eclipsed by immensely larger establishments, but, after all, there were some industries in operation fifty years ago which would astonish even the wonder-sated folk of the twentieth century. The sawmills at Ottawa, for instance, were undoubtedly marvels. There were ten of them running night and day in an endeavor to keep pace with the efforts of the ten thousand lumbermen who were busy felling the forests along the river. One of these mills boasted eighty saws and the others were very little smaller. The ten mills together turned out 180,000,000 feet of lumber a year, while 16,000,000 cubic feet of square timber was rafted to Quebec each season for shipment across the Atlantic. In that golden age of the lumber trade, it took 800 ships, manned by 25,000 men, to carry the harvest of the Ottawa from Quebec to England.

Wood Shipbuilding

These were great and picturesque enterprises and so, too, was the wooden shipbuilding industry, which was in its heyday of prosperity when Confederation came into being. At Quebec and at many a harbor and port on the coasts of New Brunswick and Nova Scotia, fine, large wooden vessels were built and launched annually in considerable numbers. There were fifteen shipyards at Quebec alone, in which from 25 to 50 ships were turned out each year. Unfortunately, except for a forced revival of the industry at the present time, wooden shipbuilding is dead and thus an interesting chapter in Canadian industrial history is closed.

However, all industry in Canada in and about the year of Confederation was not so spectacular, though to the people of the time many of the developments seemed very wonderful. In Hamilton, for instance, where foundations for future industrial greatness were even then being laid, it was deemed a remarkable feat on the part of the local manufacturers to have installed $100,000 worth of new machinery in a single year. The production of locomotives at Kingston was considered a work little short of marvellous. The erection in Sherbrooke in 1866 of a woollen factory five stories high was heralded as a most important event, while Victor Cote's new tannery at St. Hyacinthe, which gave employment to 90 hands, was regarded as a mammoth plant.

But if industries were small and scattered, the products of industry were by no means inferior. At the great Paris Exhibition in 1867, the goods of Canadian manufacturers showed to advantage. Furniture made by Jacques and Hay in Toronto was declared to be superior to anything on display. The wall hangings of the Stauntons compared favorably with the product of the English makers. The Barbers, of Streetsville, showed cloths and woolens of most creditable quality. Implements from the Jones plant at Gananoque and the Whiting plant at Oshawa, were highly commended, as were also the cigars exhibited by Davis, of Montreal.

Transportation Developments

Industrially, Canada has traveled far since those far-away days. All the mar-

velous expansion which the introduction of electricity has facilitated has come since then. The mammoth textile works with their electric drives; the great steel plants; the huge paper mills; all these and many more have sprung into being since 1867, and in no respect has the progress of Canada been more marked than in this department of national life.

Hand in hand with the growth of industry has gone the extension of transportation facilities and rapid means of communication. In 1867 the railway systems of the country, since expanded into transcontinental proportions, were limited in scope. This was especially true of the Maritime Provinces, where the stage coach was still an established and very necessary institution when the Confederation era dawned Nova Scotia was served by two short lines of road, running from Halifax to Truro and from Halifax to Windsor respectively, a matter of some hundred miles of track in all. New Brunswick likewise had but two railways, one connecting St. John and Shediac and the other St. Andrew's and Woodstock. Prince Edward Island, which has now a system of 275 miles, was without any railway at all. In short, the three Maritime Provinces among them had only about 300 miles of road in operation, whereas today their mileage extends to 3,668 miles.

LOCK No. 1, NEW WELLAND CANAL.

THE DEEP CUT, A VIEW OF THE WELLAND CANAL IN THE EARLY DAYS.

The Upper Provinces were somewhat better served. The Grand Trunk, then the longest railway in the world under one management, ran from Portland, in Maine, to Sarnia, in Ontario, and from Riviere du Loup, on the Lower St. Lawrence, to Richmond, P.Q. Its most formidable rival was the Great Western, running from Niagara Falls through Hamilton, to Windsor, with a branch from Hamilton to Toronto. Northward stretched lines from Prescott and Brockville to Ottawa, from Port Hope to Beaverton, and from Toronto to Collingwood. All the rest of the network of roads now traversing both old and New Ontario were non-existent.

Railroad Through Traffic

The idea of through traffic was only just being evolved in 1867. The Great Western, then a wide-gauge road, as were most of the railways in Canada, had laid a third rail from Windsor to Niagara Falls and built a car ferry for service across the Detroit River, in order to secure a slice of the business between the newly developed settlements in the Middle West and the seaboard. The Northern Railway from Toronto to Collingwood was paying so much attention to the traffic it was receiving from the upper lakes and trans-shipping at Toronto for lower lake ports, that settlers along the line complained of the difficulty of getting their cordwood shipped to Toronto. In fact, the promoters of the Toronto & Nipissing and the Toronto, Grey & Bruce made it a point in soliciting financial aid from the municipalities that they would serve the settlers better in this regard that they were receiving.

Communication between the Maritime Provinces and the Upper Provinces in those days was usually by coasting vessel from Halifax or St. John to Portland and thence by Grand Trunk to Montreal. The extension of the Halifax-Truro road to Pictou, completed in the Confederation year, gave a new summer route up the St. Lawrence to Quebec, while one of the fruits of the new political arrangements between the provinces was the establishment of a line of steamers to run from Montreal and Quebec to Maritime Province ports. Otherwise it was possible to take a longer stage journey up the St. John valley from the railway terminus at Woodstock to Edmundston and across the height of land to Riviere du Loup, where the Grand Trunk terminated. This was the route by which the British regulars journeyed to Upper Canada at the time of the Fenian scare.

Victoria Tubular Bridge

The recent completion of the Victoria tubular bridge at Montreal was then filling the minds of visitors with awe and astonishment. It was hailed as one of the wonders of the world, a scientific achievement without a peer in the history of construction. Its three million cubic feet of masonary, its eight thousand tons of iron, its enormous length, its great cost, were dilated upon in unmeasured terms of admiration. For the times it was indeed a remarkable engineering feat, but since then many a far more wonderful undertaking has been completed in Canada, which illustrates still further how the country has progressed.

Canada's canal system had by 1867 reached considerable proportions and comparatively speaking, traffic by water was of more importance than that it is to-day. The lakes were covered with sailing craft, while steamboats were far more numerous than they are now. Of

course, all these vessels were so much smaller than the big freighters of the twentieth century that mere numbers were insignificant. At the same time they provided a most picturesque element in the picture of Canada in 1867. The passage of fifty schooners a day through the Welland Canal was by no means an unusual experience in the year of Confederation.

The canals were much smaller than they are to-day. Those on the St. Lawrence, by means of which ships passed up from Montreal to Lake Ontario, contained but nine feet of water, while the locks were limited to 200 feet in length. Notwithstanding this, records of vessels are not uncommon which had sailed down from the upper lakes and, passing through these canals, had later crossed the Atlantic.

Conditions of Travel

Traveling conditions in the year of Confederation were none too satisfactory. As compared with the luxury of the present day, a journey even for a short distance was an arduous and uncomfortable undertaking. In the Maritime Provinces, if a traveler preferred an overland journey instead of a trip by coasting vessel, he would have to put up with the inconvenience of a wearisome ride in a big, lumbering, springless stage over rough roads, his only solace the occasional pauses for rest and refreshment at old-fashioned change houses. In the Upper Provinces, he would have to contend with the wretched service of what were referred to at the time as the most poorly conducted railways in the world.

Two trains a day in each direction were sufficient to accommodate the traffic between the two largest Canadian cities. One made the journey by day, the other by night, and the run was scheduled for something like fourteen hours. The locomotives burned wood and there were frequent stops en route to re-load the tenders. Cars were small and light, the track poorly laid and the bumping and jolting terrific. One wretched tourist who endeavored to beguile the telium of the journey by a game of draughts found to his disgust that it was quite impossible to keep the men on the board.

Postal System

The postal system in Canada fifty years ago differed very little from the present system except that very much higher rates of postage had to be paid, and it took much longer for letters to reach their destination. The rate to points in Canada, that is, Ontario and Quebec, was five cents; to the United States, 10 cents, and to England, 12½ cents. A special weekly service to Halifax, via Portland, having been arranged, a business man in Toronto or Montreal could send a communication to Nova Scotion for the sum of 12½ cents. As for British Columbia, it cost 25 cents to forward a letter to the Pacific Coast.

Statistics for the year 1863 show that there were in the Upper Provinces, 1,974 post offices in that year and that the number of letters carried was 11,000,000. New Brunswick had 375 post offices, in which 833,625 letters were handled, and Nova Scotia 493 post offices, with 1,467,726 letters. The year's revenue for the three provinces was $853,778, and the expenditure, $896,303. As an indication of the extent to which the postal service has since expanded, it may be said that in 1915, the revenue for all Canada was over thirteen million dollars and the expenditure nearly sixteen millions.

Telephones

While the telephone was unknown in 1867, the telegraph and the Atlantic cable were both in existence, and so far as telegraphic communication was concerned, Canada was well served. Indeed, in Nova Scotia the boast was made that they had more lines of telegraph per inhabitant than in any other country in the world and, what is even better, lower rates. In Ontario and Quebec, the Montreal Telegraph Company, with over 3,000 miles of wire, controlled the situation, while in the Maritime Provinces the lines, about 2,000 miles in extent, were controlled by the American Telegraph Co. As there are to-day over 200,000 miles of wire in the telegraph systems of the country, it is obvious that here again there has been vast development.

The story of the telephone is all contained within the limits of the Confederation era. There were no telephones when Confederation was born. To-day there are between six and seven hundred thousand instruments in use, with over a million and a half miles of wire connecting them.

Electrical Street Railways

Electric street railways have been another modern development. In fact, in the year of Confederation, horse cars had only just come into use. Toronto's system had been opened in 1861. It consisted of six miles of track on Queen and Yonge streets, with eleven cars and 70 horses, a total investment of only $175,000. Montreal had also about six miles of track with similarly small equipment. Halifax was a third city with a system of horse cars at that time. The innovation was not welcomed. One critic complained that "the street railway is an institution for the benefit of those who ride, at the expense of those who drive, and is a flagrant violation of the rights of the majority. The horse railway is a permanent obstruction; it practically divides a wide street into two narrow ones and a narrow one into two lanes. It is questionable whether it will be found profitable in Canada."

In the light of this hostile attitude, it is interesting to note that the tiny systems in the three leading cities of 1867 have since developed into a vastly important series of electric lines, located in practically every city in Canada, operating upwards of 1,700 miles of track and carrying annually six hundred million passengers. The capital invested in them amounts to over $150,000,000.

Trade and Finance

Trade and finance have shown marvelous expansion in the fifty years of Confederation. When it is considered that in 1868 the country's total trade only amounted to a little over $131,000,000, of which $57,500,000 represented exports; that the export of manufactured products in that year scarcely amounted to $2,000,000 and agricultural products exported were under $13,000,000 in value, then the growth becomes all the more remarkable, for, in 1916, Canada's trade amounted to nearly a billion and a half dollars; her exports of manufactured products to $242,000,000, and her exports of agricultural products to $250,000,000. Her mineral exports in the same period jumped from $1,800,000 to nearly $67,000,000, and the products of her fisheries from $3,500,000 to over $22,000,000.

The development of trade has been graphically reflected in the expansion of the financial institutions of the country, notably the chartered banks and the insurance companies. There were as a matter of fact, more banks doing business in 1867 than there are to-day, but the banks of the Confederation year were very much smaller and, in several cases, they were in a notoriously shaky condition. In all, there were twenty-six of them in existence, with a paid-up capital among them of approximately thirty millions, or about a quarter of the paid-up capital of the twenty-one institutions now operating under Dominion charters. There were about 120 branches doing business, the large majority of which were located in the Upper Provinces.

Since 1867, sixteen of the twenty-six chartered banks on the list in that year have disappeared, either through failure or amalgamation, leaving but ten of their number to carry on the traditions of the pre-Confederation days. The survivors, in point of age, are the Bank of Montreal, Bank of Nova Scotia, Bank of British North America, Bank of Toronto, Molson's Bank, Bank Nationale, Merchants Bank, Banque Provinciale, Union Bank, and Canadian Bank of Commerce. Eleven new banks have been established, bringing the present total up to twenty-one.

To-day Canadian banks have over 3000 branches in Canada alone, not to mention agencies in the United States, the West Indies, and elsewhere. Their assets have grown since 1867 from seventy-five millions to well over two billions; their liabilities from forty millions to over eighteen hundred millions. They have deposits of over fifteen hundred millions as compared with twenty-five millions fifty years ago, and their circulation has expanded in the half-century from nine millions to over $132,000,000.

Insurance

Life insurance was the smallest of Canada's financial institutions in 1867. Only one Canadian company—the Canada Life, which had been organized in 1847—was operating, and the total insurance in force of all companies, including British and American, did not exceed $30,000,000. Progress in this one business alone has been little short of phenomenal. Company after company has been organized until to-day no fewer than twenty-six domestic companies are

reporting annually to the Dominion Department of Insurance, not to speak of fifteen British and sixteen American companies.

By the end of 1916, the insurance in force on the lives of Canadians amounted to nearly a billion and a half dollars, of which nine hundred millions was carried by our own Canadian institutions. The latter, whose assets in the year of Confederation were a mere bagatelle, now show accumulated wealth approximating three hundred million dollars; their annual income runs to over sixty million dollars; while they disbursed last year to policyholders or to their beneficiaries nearly twenty-five million dollars in cash.

The business of fire insurance has enjoyed a similar expansion. Our Canadian companies, then few in number and uninfluential, had at risk in 1867 about fifty million dollars, on which they were receiving premiums of somewhat less than half a million dollars and paying losses of from a quarter to half a million dollars a year. Last year, the domestic fire companies had $663,758,129 at risk, on which they were receiving premiums of nearly five million dollars, while they met losses during the year of over half that amount.

One might proceed and produce figures bewildering in their detail to demonstrate how far Canada has progressed in every department of business activity since 1867. The tremendous expansion of agriculture due to the opening up and settlement of the West; the development of mining, which is placing Canada in the forefront of the mineral-producing countries of the world; the growth of the fisheries; the extension of hydro-electric power in industry; these and a hundred other matters might easily be referred to as affording means of gauging the country's fifty years of progress. However, enough has been written to give a faint idea of the Canada of fifty years ago and with this in mind it is not difficult to picture mentally the extent of development.

CANADA'S COAL OUTPUT

THE Mines Branch of the Department of Mines, at Ottawa, has received from the principal coal mine operators returns of their production during the first three months of 1917, on the basis of which the following estimates have been made of total production during this period.

According to these estimates the total production of coal during the first quarter of 1917, was 3,590,991 short tons, comprising 1,233,934 tons in January; 1,143,956 tons in February, and 1,213,101 tons in March. Corresponding records for the year 1916 are not available for comparison.

The record would appear to show that the average rate of production in Nova Scotia and British Columbia was less than the average rate of production during 1916, but greater in the provinces of New Brunswick, Saskatchewan and Alberta.

The exports of coal during the three months' were 501,570 tons, as against exports of 737,744 tons during the corresponding period of 1916.

The imports of coal during the three months were 3,921,824 tons, as against imports of 4,002,892 tons during the corresponding period of 1916.

The production of oven coke during the first three months of 1917 was 308,690 tons—the imports during the same period being 207,139 tons, and the exports 5,606 tons.

Revised statistics for 1916, as compiled by the department, show that the total consumption of coal was 29,865,856 short tons, against 23,906,692 in 1915. Production in Canada was 14,483,395 tons, against 13,267,023 in 1915, and imports, 17,850,603 against 12,465,902. Production figures by provinces as given below show decreases in the East, but increases in the West:

Production by provinces:—

	1915 Short Tons	1916 Short Tons
Nova Scotia	7,463,370	6,912,140
New Brunswick ..	3,360,818	143,450
Saskatchewan ...	2,065,613	281,300
Alberta	240,107	4,559,054
Brit. Columbia ...	127,391	2,584,061
Yukon	9,724	3,300
Totals	13,267,023	14,483,395

PIPE COVERING

IT may be said that in most cases it pays to use the best commercial pipe covering obtainable, because where the material is paid for many times over during the first year by the saving effected by its use, the first cost loses much of its weight as a determining factor in the selection of type of covering to be used. In view of the results of thickness tests, it is a deplorable fact that few steam lines at the present time are provided with thick enough a covering for the greatest net saving. However, where fuel is cheap and the lines are in use only a small percentage of the time, the cheaper coverings have their advantages. Also, there are places, as on some heating systems, where the heat lost through the coverings is not wasted and the object of covering the pipes at all is to keep tunnels, etc., cool enough that men may work in them. Therefore, a careful study of conditions is necessary before a certain type of covering can be recommended for a given piece of work.

The durability of materials used for pipe coverings is a very important factor in determining the most economical covering for a given set of conditions. It has been pointed out that the proper basis for comparing costs is the cost per year and not the first cost of the material. This is true because the covering giving the greatest length of service for a given first cost and efficiency is obviously the one to select. In general, fibrous coverings are more durable than the molded forms; since the latter tend to revert to their original powdered state due to vibration and rough usage, while those made of fibrous material firmly felted together show no such tendency.

SUPPORTING HORIZONTAL RETURN TUBULAR BOILERS

THE method of supporting horizontal return tubular boilers is of more importance than is usually realized. Such boilers, no matter what their length or size, should be supported at no more than four points. If boilers are long it is common to support them at six points. In order to prevent the end supports from leaving their bearings, springs are often placed under the middle brackets, but this does not render the pressures on the supports equal and is only a makeshift. It is a principle in mechanics that if a body rests on three points, the pressures on these points can be determined and will not change even if the points change their positions or levels. A 3-legged stool adways rests properly on its legs, even when it rests on an irregular floor, but a stool with more than three legs never presses equally on each.

This shows that, in supporting a horizontal boiler, the three-point principle should be applied. To obtain this effect and yet have the boiler held up at four points, two points at one end are supported in the usual manner and the other two are connected by links to an equalizing lever working on a pin passing through overhead supporting beams. When a boiler is supported in this way, the stress in the plates due to the weight can be made proper, and will never change, no matter how much the brickwork may settle, but, if this system is not used, the stress at one point may be sufficiently great to be a serious matter.

BOILER RIVET HOLES AND RIVETING

RIVETING is now generally done by hydraulic machines, which have shown themselves superior to any other kind. In consequence of the slow movement of a hydraulic plunger, the rivets have time to enlarge and fill the holes; and from the solidity of action and steady holding power of the machine the plates are firmly pressed together, with the result that joints riveted by this type of machine are tighter than those made by any other.

It is a common practice to punch the holes of boilers ⅛ in. or ¼ in. small and then to drill them to size with all plates and covering strips in place. This is a great advance in practice over punching to size, but it is not satisfying to the imagination, and it may be one reason why plates exposed to the hottest gases crack between the rivets and their edges. Another reason for such cracking may be bulging caused by too much pressure by the riveting machine on the rivet. Sometimes such bulging is very apparent. A still further advance in practice is to punch one butt strap for each joint with small holes and use it as a template for drilling not only itself but the main plate and the other butt strap. Similarly, the holes in one plate of a circular seam may be punched small and used for a template for drilling the other holes. The best way, however, and the one which should be adopted everywhere, is to drill all holes from the solid.

Design and Constructional Features of Turbine Pumps *

By A. E. L. Chorlton

There are milestones in the history of the evolution of the centrifugal pump, yet the wide extent of its successful application in turbine form is due to the overcoming of practical difficulties, both mechanical and hydraulic. This work has only been accomplished after prolonged experience, and success has only been reached after tedious and careful study and improvement of small details. In what follows, there is described and traced the development of some of the methods of successfully overcoming the difficulties referred to, while attention is drawn to points in design which are the result of the author's experience, the latter extending back to the infancy of the Turbine Pump Principle in engineering achievement.

THE turbine has become so highly successful as a pumping engine for duties of all description, that no apology is needed for offering a few practical notes on the design and construction of its detailed parts. It will be convenient to consider the subject under the headings of the various component parts of a pump. These are:—

I.—The stator, which consists of (I a) the casing or housing, and (I. b) the guide vanes or appliance for converting velocity energy into pressure energy.

II.—The impeller (considered separately).

III.—The balancing appliance — hydraulic or mechanical.

IV.—The rotor, considered as a whole, and including the spindle with its projecting sleeves, impellers, and in most cases the balancing appliance.

V.—The bed, and other details, bearings, stuffing boxes.

Of these components III., IV., and V., broadly speaking, are the factors governing reliability and resistance to wear, and I. b, and II. are those determining the efficiency.

It is proposed to deal at greater length with III. and IV., for the reason that they have probably been less discussed than the others, also their practical importance is of the greatest moment, but the whole subject cannot be adequately treated within the confines of a paper written during the present time. The chief points only of items I., II. and V. will be briefly reviewed:—

I.—The Casing

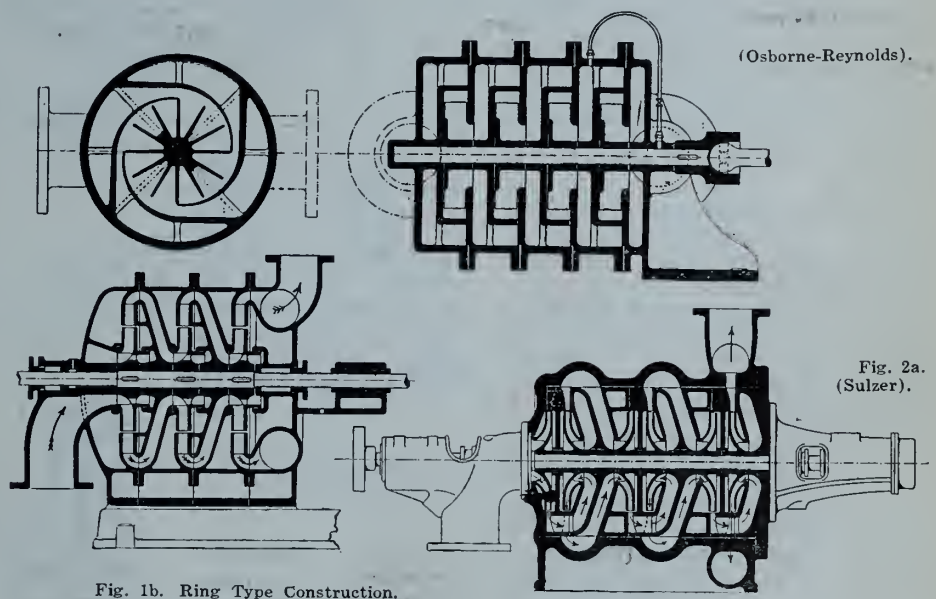
The individual impellers of a turbine-pump revolve in chambers or cells containing the outward flow guide-passages and the return conduits for the water; these chambers may be part of a whole in which the outer body is cast in one piece, or, an aggregation of a number of distinct cells without any outside envelope. There are, therefore, two main types:—

1—The Osborne-Reynolds or divided type, and sometimes called the "ring-type."

2—The Sulzer, integral or one-piece type, sometimes called the "cylindrical" type. Recent American practice provides a variation of this type with the housing in halves divided on the horizontal centre line.

The two main types are diagrammatically illustrated by Fig. 1 (a and b) and Fig. 2 (a and b), with variations in Figs. 3 and 4.

The Osborne-Reynolds pump and its evolution was dealt with by the author in collaboration with Dr. E. Hopkinson, in some detail in a paper read before the Institution of Mechanical Engineers in January, 1912. This type was followed at a later date by the integral one of Sulzer, which had, for a period, a considerable vogue. An examination of the present-day practice of various makers will prove, however, that the ring-type has ultimately proved the preferred one.



(Osborne-Reynolds).

Fig. 2a. (Sulzer).

Fig. 1b. Ring Type Construction.

SECTIONS SHOWING TYPES OF TURBINE PUMP CASINGS.

The Reynolds pump has always used a separate cell for each impeller, and it is therefore correct to say that the ring-type of pump owes its inception to Great Britain. The continental form of the series turbine-pump is due to Sulzer (first pump 1896); in this type a monoblock housing was used for all the chambers or cells, the guide-vanes being inserted from the end.

Before dealing with either type or variations arising out of them, it is advantageous to consider the essential functions of the chamber or housing of a turbine-pump. Primarily, each cell consists of (1) the outward flow guide-passages in which the kinetic energy of discharge from the turbine-impeller is converted into static head, and (2) the return water-passages back to the centre for conduction to the next impeller; a complete housing is a collection of such cells.

Obviously, in the design, commercial considerations must have a material guidance on theoretical claims. Against the requirements for best theoretical conversion of kinetic energy must be matched the allowable limits of dimensions conformable with commercial possibilities, and, in the interests of efficiency, special attention must be paid to the arrangement and dimensions of the divergent channels or guide-passages. As is well known, the form for guide-passages is represented diagrammatically by Fig. 5, and this passage must be disposed in some form to lie conveniently in the desired casing. The general character will be either a simple outward flow type in one plane, Fig. 6, or a mixed type outward and axial in two planes, see Fig. 7 (a and b) and Fig. 8.

The divergent angle of guide-vane, Fig. 5, for best efficiency was shown by Professor Gibson to be 10° to 11°. In many cases such a small divergent angle leads to a large overall diameter guide-vane in order to give a sufficiently reduced speed of water to permit reversing its radial direction, and the result is a very heavy casing in consequence. For this reason divergent angles of 15° are

*From a paper read before the Institution of Mechanical Engineers.

commonly found in practice. Evidently a more efficient pump will sometimes be heavier and more expensive than one less efficient, and commercial considerations must provide the final deciding factor between efficiency and weight. There is, of course, a school of design which believes in dealing with a proportion of the velocity conversion in the wheel itself, thus leaving less to be dealt with in the guide-passage; the extent, however, to which this method can be used for weight saving is very small, if any. The various assemblies of passages may clearly be grouped into:

A—Tangential and radial with return radial (see Fig. 6 and Fig. 1, b).

B—Tangential and spiral (see Fig. 7 (a and b) and Fig. 8).

C—Combinations (see Figs. 9, 10 and 11).

The Osborne-Reynolds pump (1887 and 1875 type) employed an early form of the B assembly, and has adhered to this type up to the present day, various improvements being embodied from time to time, in some of which the author was concerned. On the Continent of Europe, Messrs. Sulzer introduced in 1896 design A, and the author believes they have made little departure from the type beyond a considerable simplification of their early arrangement of passages. Fig. 2 a Speaking generally, combination designs C are not so efficient as the simpler types A and B, owing probably to the hydraulic loss through changing the radial direction of the water at high speed.

From a works construction point of view, "ring casings," Fig. 1 (a and b), are the most economical, and in practice give high efficiency. In the form similar to that shown in Fig. 12, the author some years ago was able to mould and cast ring-casings without cores, machine moulding being adopted, and the cost per chamber coming out at a very low rate.

For "cylindrical" casings, Fig 2 (a and b), a complete pattern is required for each size and variation in number of chambers. Its accessibility, however, and ease of dismantling is sometimes considered to be greater than with the "ring" type, though this is, to a certain extent, a matter of opinion. A great drawback to casings containing separate cells is that, on account of the sliding fit between the intermediate pieces and casing, an unknown amount of leakage constantly takes place between the cells. With a "ring" type of pump, leakage is instantly detected and can be remedied. As a commercial proposition the author unhesitatingly favors the divided or "ring" type of casing, and when properly carried out, has met no difficulty with it in practice.

Fig. 2b. Continental pump—cylindrical casing construction.

Fig. 4. Combination of cylindrical and ring features.

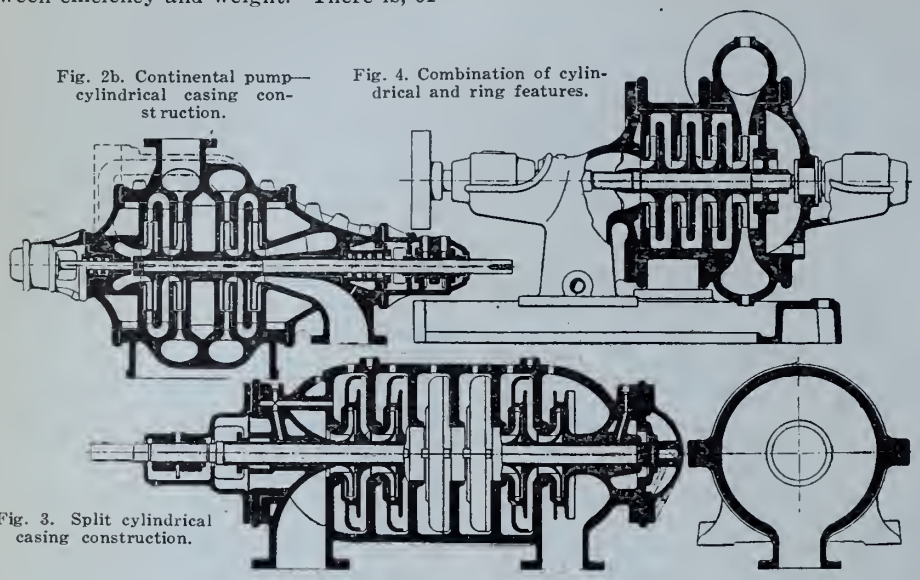


Fig. 3. Split cylindrical casing construction.

SECTIONS SHOWING TYPES OF TURBINE PUMP CASINGS.

Finish of Guide Passage Surfaces

Before leaving this part of the subject, a word about the finish of guide-passage surfaces is necessary. For best efficiency the throat of the passage at least, if not the entire passage, should be gun-metal or bronze, as iron does not preserve a sufficiently good surface for high velocity conditions. Common practice is to provide only three sides of the guide passage in bronze, Fig. 13, but this can only be defended on grounds of cheaper first cost. For best results a bronze-plate should be provided to box-in the passage, the plate being attached to the guide-vane casting or dowelled to the casing. Guide-vanes are sometimes cast completely boxed in, and this method necessitates hand finishing of the passage by file and scraper; open vanes, however, lend themselves better to cleaning out and accurately finishing either by hand or by machining. A good smooth surface is essential for the best results and will always justify the increased cost. The method adopted of securing guide-vanes from rotation and vibration must be a thoroughly sound one or trouble will result.

II.—Impellers

Impellers are either single entrant, or double entrant. The first is almost universally in use for multicellular pumps, and the second almost exclusively for single-chamber pumps; it is only proposed to deal with the single entrant form. Multicellular pumps use the single-eye wheel in three forms:—

(a)—Unbalanced, unequal side area, one rubbing shoulder, Fig. 14.

(b)—Unbalanced, equal side areas, two rubbing shoulders, Fig. 15.

(c)—Balanced—on paper, Figs. 16 and 17.

There are other types, mixed flow, radial and axial, etc., but these are not used to a sufficient extent to be worth including in this paper.

Type (a) may be said to be the one now generally used, that is, the preferable design.

Type (b) has certain advantages for machining, etc., but probably requires a stiffer shaft. Also, having no central sup-

Fig. 5. Form of Guide Passage—Throat Only.

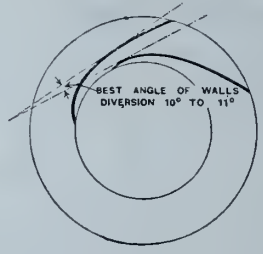
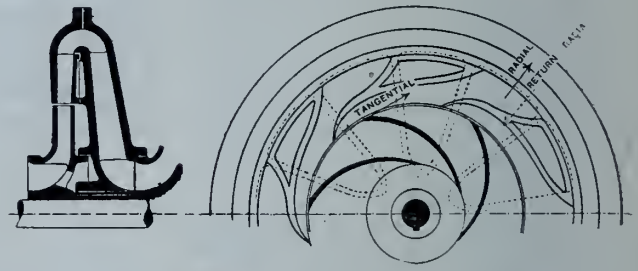
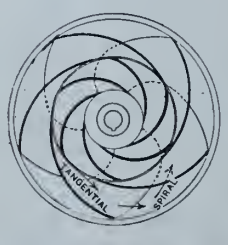


Fig. 6. "Stage" or Cell." Flow Tangential and Radial: Return Radial.





a—Flat.

b—Perspective.

Fig. 7. Flow Tangential and Spiral.

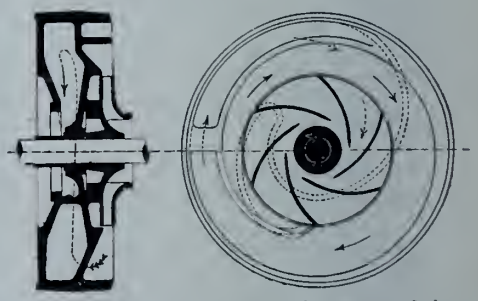


Fig. 8. Single "Cell," Single Passage Only.

SECTIONS SHOWING TYPES OF TURBINE PUMP GUIDE VANES.

ports, it tends to rotate the suction water of the next impeller and may be attended by greater stage leakage due to the increased annular running clearance.

Type (c) has the paper advantage of being in balance; actually it is a poor approximation to a balance. Disturbing factors are set up by: differences in side pressure on the impeller due to differences in volume and surface-form of the water contained on the two sides of the impeller, Fig. 18; difference of quantitative leakage through the two shoulders; and high-pressure leakage into one side of the impeller from the stage above, and leakage from the other side of the impeller to next low pressure stage below. Therefore, in practice, it is necessary to provide an additional end balancing device of the hydraulic type, or a mechanically positioning fitting such as a thrust-collar or ball-bearing; a method, especially for mine usage, not to be recommended.

The internal design of all impellers is governed by the same controlling features:—

power and size of motor, the combination will generally come out cheaper.

The maker who elects to change his impellers and diffusers to suit the demands of the inquiries as they come in, will obtain a higher percentage of orders than one who has standardized his, even though the latter may have reduced costs by making in large quantity. In considering if in any way it is possible to meet the designer's requirements without losing all the advantages of repetition manufacture, we may first take the in-

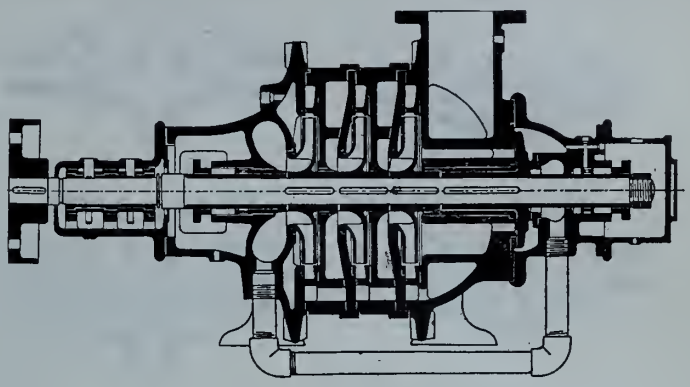
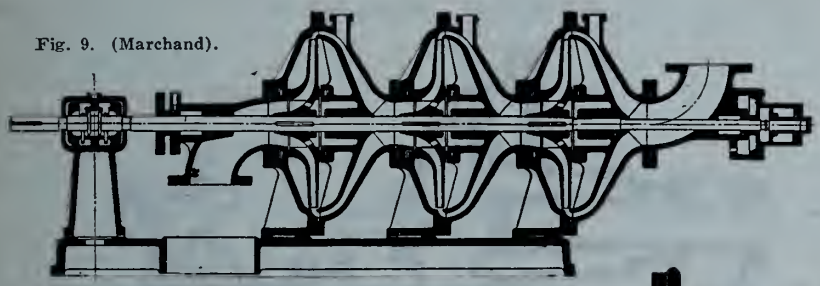


FIG. 12. MODERN FORM OF TURBINE PUMP (MATHER & PLATT).

Fig. 9. (Marchand).



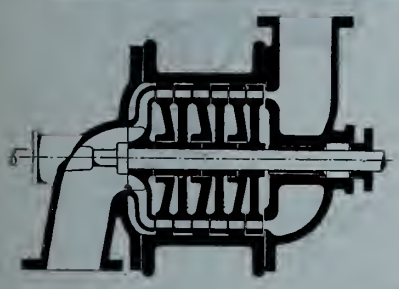


Fig. 11. Combined Axial and Spiral Flow.

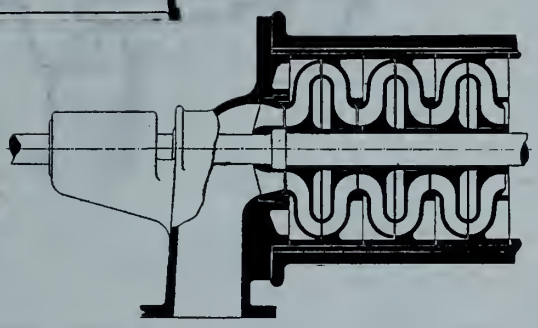


Fig. 10. Combination of Tangential Axial and Radial Flow (Escher Wyss).

SECTIONS OF TURBINE PUMPS SHOWING COMBINATION PASSAGE ASSEMBLIES.

1.—The entrance or inlet angle of vane.

2.—The delivery or exit angle of vane.

The entire design must, while based on these considerations, consult the convenience of the workshop to the utmost degree possible without departing from required dimensional accuracy. The standing difficulty with turbine-pumps, from the manufacturing point of view, is their constant variation to meet the infinite number of conditions of varying head, speed, and quantity encountered in practice. Whatever efforts are made, it seems impossible to keep to a small number of standard impellers if the highest efficiency is to be reasonably well reached each time. Efficiency, it should be noted, is really the prime factor in design and not apparent first cost, for the pump is very often driven by an electric motor of greater value. If, therefore, by the use of a pump of higher efficiency, a reduction is effected in the necessary let angle. This depends on the resultant of the (supposed) radial flow of the entering water and the peripheral speed of the inlet tip itself, and it usually varies between 15 degs. and 30 degs. If we select to use always 15 degs. we might suffer in some cases to the extent of 3 per cent. or 4 per cent. If we take two sizes, 15 degs. and 25 degs., and make a liberal provision of inlet width, or, as some designers phrase it, make an adequate allowance for "weir coefficient" at entrance, we shall only drop perhaps 1 per cent. in exceptional cases; so it seems possible to do something in the way of standardizing the inlet angle.

Current Ideas Concerning Inlet Angle

One might refer, in passing, to some of the current ideas concerning the inlet angle and the condition of the water at entry to the impeller. Some designers have maintained that very great accuracy of the inlet angle is vital to high efficiency, in spite of the fact that in the ordinary unobstructed eye it is impossible to say what the absolute velocity and direction of the incoming water is, and therefore, to estimate precisely what the correct inlet angle should be is impossible. Further, the behaviour of the incoming water varies with every rate of flow, and the only way to foretell its condition would be to insert inlet guide-vanes; this, however, in such experiments as the author is aware of, has proved an objectionable practice and only introduces further losses in the pump. Another school holds that it is an advantage purposely to introduce a forward whirl in the water at the eye with the object of helping the water into the impeller. If such an initial whirl is used, the work necessary to create it is necessarily done by the pump itself, and it is, therefore, questionable if this does not entirely overweigh any possible gain.

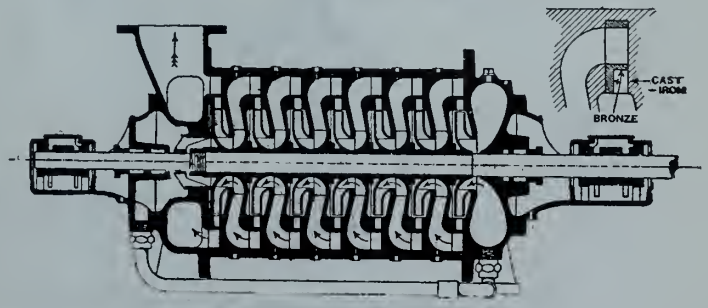
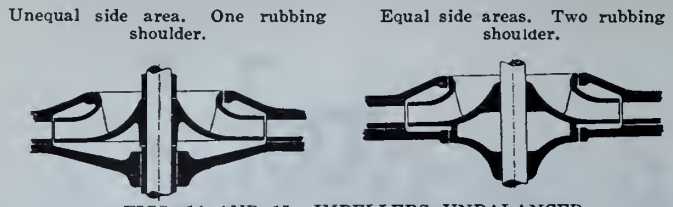
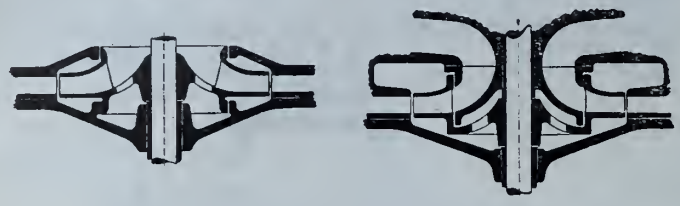


FIG. 13. (FARCOT).

The discharge angle depends on the resultant of the peripheral speed of the wheel and the radial out-flow, the variation of which is so great it seems impossible to devise any standardization. To meet quantity variation two widths of impeller may be used, and to meet required speeds of revolution it is usual to allow a small percentage variation in the impeller diameter to suit special demands; this latter, however, is conveniently done without pattern or casting alterations.



FIGS. 14 AND 15. IMPELLERS UNBALANCED.



FIGS. 16 AND 17. IMPELLERS BALANCED.

The foregoing considerations lead to the conclusion that nothing less than a special core-box will be required for each case, and it is quite usual to meet the difficulty in this way. Evidently, however, a most valuable appliance would be a special form of core-box, which in itself was more of a standard and could be adopted for manufacture in quantity; this result might be effected by fitting in vanes of a flexible nature, so that the necessary alteration and adjustment would not be great, and the whole outfit would come out cheaper than if a pattern-maker had to build a fresh box and fittings for each new demand. As the accuracy and smoothness of the impeller is of great importance, the author has always looked to machine moulding, and to a special machine like a wheel-moulding machine, for the purpose; he has not, however, as yet, arrived at the final design for such.

Impeller Surfaces

The surfaces of the impeller, both inside and out, play an important part in the efficiency of a turbine-pump. The smoother the outside surface the less the power lost in disk friction, and the less the power wasted in revolving idle "dead-water." An interesting point to note is that the greater the speed of revolution of the "dead-water" (that is, the greater the power absorbed in this way), the less the leakage from the periphery of the impeller; but a little consideration will show that greater overall economy is gained by reducing the wasted power in idle revolution to a minimum. As regards the internal smoothness of the passages of the impeller, it is usual practice to clean up the surfaces as well as possible with file and scraper. Impellers have been built up with one loose side so as to permit of machining or more effectively cleaning the interior; and it is evident that with individual impellers producing high heads the results would well repay the extra cost. Objections to this practice are the difficulty of making attachment of the two parts and the extra weight necessary to provide attachments.

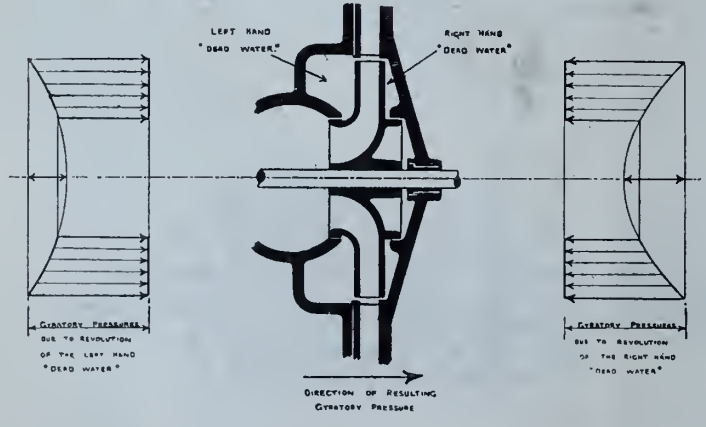

LEFT HAND "DEAD WATER"
RIGHT HAND "DEAD WATER"
GYRATORY PRESSURE DUE TO REVOLUTION OF THE LEFT HAND "DEAD WATER"
GYRATORY PRESSURE DUE TO REVOLUTION OF THE RIGHT HAND "DEAD WATER"
DIRECTION OF RESULTING GYRATORY PRESSURE

FIG. 18. EFFECTS OF GYRATORY PRESSURE ON END THRUST.

III.—Balancing Appliance

The experienced designer knows, from practical knowledge, that even if a group of impellers, or even a single impeller, is theoretically balanced by equivalent areas subject to pressure, it will not in actual practice be free from all end thrust. Apart from variable leakage at the two sides of an impeller, which, by the way, is the principal cause of end thrust, we often have variable side surface both of the impeller and the cell chamber. If the conditions of capacity or surface of the two clearance-chambers vary, the resulting pressures will vary and an axial thrust is set up. Professor Gibson has investigated the effects on efficiency (power lost) due to varying the side clearance of the impeller, and he took readings of circumferential pressures set up by revolving disks, but he apparently did not plot out the resultant effect in end-pressure. This interesting problem is discussed in a paper by F. Zur Nedden, where use is made of the results from both Professor Gibson's and Professor Unwin's revolving disk experiments. The general effect of the gyratory pressures set up is indicated in Fig. 18. It is seen that the speed of the revolving "dead" water at the two impeller sides sets up pressure in opposition to the leakage pressure from the impeller-tip, as already pointed out; the faster the water revolves the greater the resistance to leakage, and the less the resultant pressure due to that leakage. It can readily be seen, therefore, that the effect of the chamber at one side of a wheel having greater capacity than the other, or having more obstructions in the way of ribs, pockets, or exceptional roughness, etc., plays some part in the determination of end-thrust.

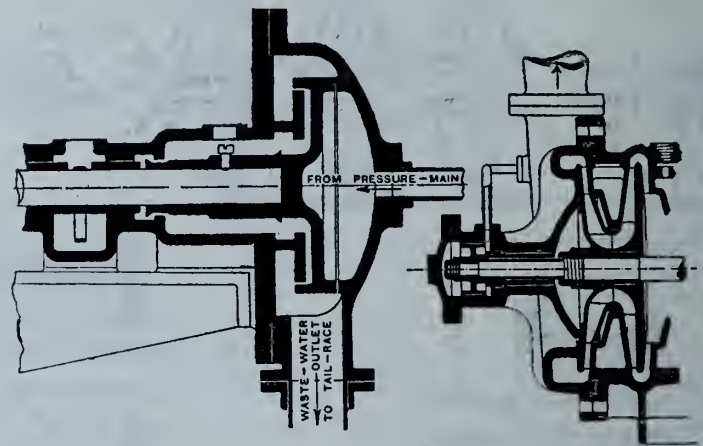


FIG. 19. HYDRAULIC AXIAL BALANCING DEVICE (FRANCIS).

FIG. 20. PUMP (RATEAU) SHOWING HYDRAULIC COMPENSATOR.

All the earlier turbine-pumps employed some form of thrust bearing, either of the collar or the ball type, to keep the impellers in correct alignment with the guide passages, and it was not until much trouble had been experienced with these that hydraulic control was ultimately adopted. Experience showed that much higher end pressures were set up than were ever anticipated, but for a period

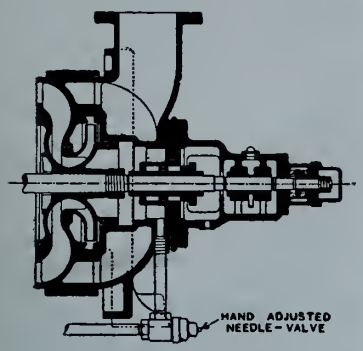


FIG. 21. HAND ADJUSTED BALANCER.

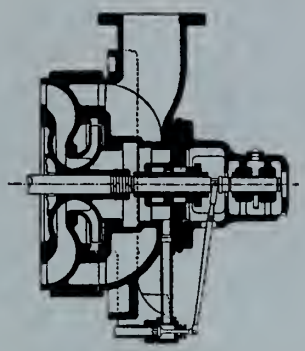


FIG. 22. MECHANICALLY ADJUSTED BALANCER.

mechanical devices were persisted in, improvements being made attempting to withstand the excessive loads, and scant notice, it would appear, being taken of water-turbine practice where for many years it had been the custom to relieve axial thrust hydraulically. Fig. 19 illustrates an hydraulic balancing device in use on Francis turbines, and which, if properly proportioned, is automatic, and thus embodies all the essential points of many present turbine-pump balancers. One should bear in mind that the relation between the calculable axial thrust and the thrust realized in a water-turbine is much closer than in a centrifugal pump of the multi-stage type, the reason of this being that the disturbing factor in a high-lift pump is the leakage from stage to stage.

The well-known application of turbine-pumps to high lifts by Messrs. Sulzer at Horcajo Mines in 1898, was carried out with back-to-back impellers, and a ball thrust-bearing was provided to take the end-thrust (in one direction only), which is inseparable from this arrangement of impellers. In 1901, Professor Rateau was manufacturing pumps with end-thrust approximately eliminated hydraulically by his well known method of shroud reduction, and provided with a balancing piston, Fig. 20. This method was not automatic, and the pressure on the piston could only be adjusted by means of a hand-operated throttle-valve. However, this was the first step, and the automatic control of the necessary pressure on the balancing device and determined by the end movement of the spindle followed as a matter of course. The development of the differential type of balancer carried out under the author's direction in 1913, extended over several years, progressing step by step from a hand-adjusted needle-valve, Fig. 21, regulated to produce the required balancing pressure, to a mechanically-operated needle-valve, Fig. 22, actuated by the axial movement of the spindle, and then through several forms of rotating throttle-valve disposed on the spindle itself and actuated by the same means. Further reference to the final balancing appliance (diagrammatically shown in Fig. 23) will be made shortly.

In 1906, Messrs. Sulzer brought out their device for relieving thrust shown in Fig. 24, and the principle used has been followed by many other makers and introduced with many variations. The action of the Sulzer device is simple; it comprises a single plate with a throttling device, through which the pressure water has access to the plate. The area of the plate is sufficient when acted on by a somewhat throttled delivery-pressure to overcome the tendency of the rotor to travel in the opposite direction. As the pressure gradually rises before the plate, its increased power carries the rotor to the right until further motion is arrested by the escape of the increased pressure through a widening annular space between the plate and its facing seat. An ultimate running position is reached when the leakage through the clearance between valve and seat is sufficient to maintain a pressure at the back of the plate, equal to the set of the rotor in the opposite direction. It will be seen that the balance is quite automatic in its control, end-movement in either direction taking place until stability is reached.

Without going further into the detailed evolution of automatic control of the hydraulic end-balance of the turbine, it is sufficient to say that the devices adopted resolve themselves into two basic forms:—

(a) Single acting (simple), of which the Sulzer, Fig. 24, is the general type.

(b) Double acting (differential), of which Fig. 23 is the type, and Fig. 13 a modification.

Other single-plate forms are shown in Figs. 25 and 26. In the first of these the throttling agent, a small nipple, is removed to the discharge side of the plate, thus giving, in a measure, a double action to the plate; the quick action and limited travel due to the second face of the differential type is not obtained, however, and there is a possible disadvantage in the small aperture when dealing with impure water. The second example combines some of the points of both forms of balancer, but as the pressure in the spent-water chamber is always augmented by high-pressure leakage into the low-pressure side of the plate, the device is, obviously, relatively extravagant in leakage water, and must therefore be considered inefficient.

The general effect of wear on single-plate balancers is increased leakage, the outcome of which is further end-movement in one direction until finally the impeller discharges do not match their guide-vane entrances, but become off-set. This tendency in hydraulic balancers led the author to devise form "b," or the double-action control with which such difficulties are overcome.

Fig. 23 (also in Fig. 12), finally shows the present standard double-plate or compound differential balance arrangement. The balance-piston and regulating valve are combined, and form a balance-disk with two active throttling surfaces floating between two fixed seatings with a minimum clearance. All the working faces are arranged vertically so as to be independent of possible vibrations of the rotary system. The pressure-water, escaping from the rim of the last impeller, passes through the holes h, into the pressure chamber m, from which it escapes along the throttling surface of the balance-valve into the regulating pressure-chamber k, and from there, past the

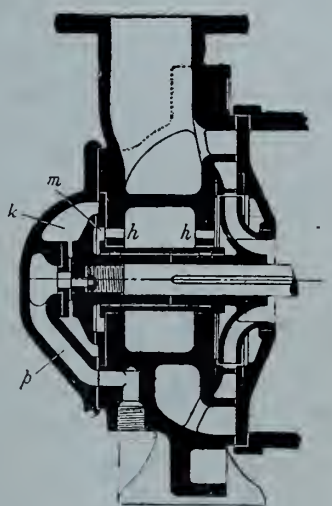


FIG. 23. DIFFERENTIAL HYDRAULIC BALANCER.

FIG. 24. SINGLE PLATE BALANCER (SULZER).

small throttling surface into the escape-pipe p, leading preferably to an open drain, or, back into the suction-chamber of the pump. The double-plate balance appears to be the most sensitive automatic balancing device in practical use, for by it, closing up of the plate on the

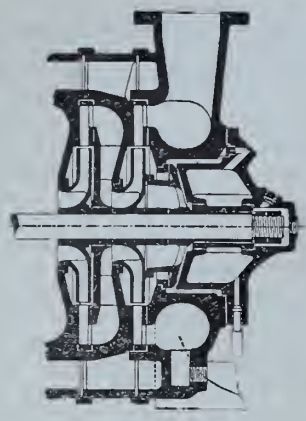


FIG. 25. (MILLINGTON.

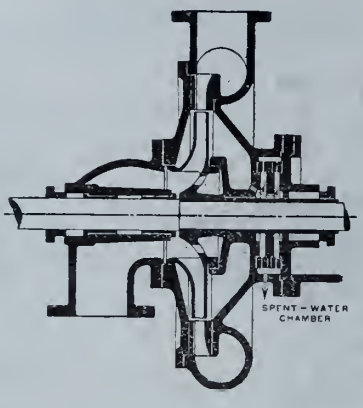


FIG. 26. (SCHEURMANN).

SINGLE PLATE BALANCERS.

large throttling face causes an opening out on the small one, thus multiplying the balancing effect; a movement of a thousandth part, or so, of an inch being all that is required to counterbalance the most extreme and sudden changes of the hydraulic equilibrium of the pump. The other and most important feature of this auto-plate balance is that it always maintains the central position of the impellers, even if the throttling surfaces become worn, as is invariably the case when pumps are working on gritty water.

A continental form arising out of this type is shown in Fig. 27, and it is obvious that the same remarks concerning extravagance in leakage water apply to this example as to Fig. 26. The arrangement of the balancer at the end of the spindle outside the external bearings is not a good one, for the reason that a high-pressure gland at the delivery end of the pump is still required, and an additional gland also for the balancer-housing. A single-plate balance made by the same firm as the above is shown in Fig.

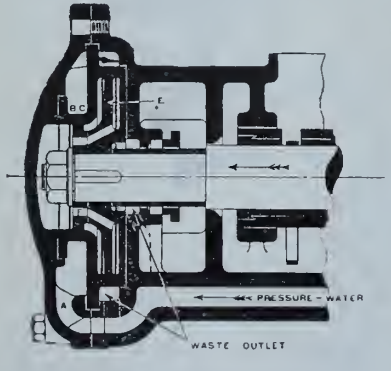


FIG. 27. DIFFERENTIAL.

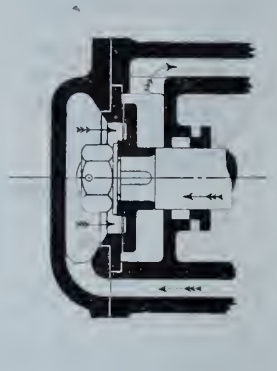


FIG. 28. SINGLE PLATE.

CONTINENTAL HYDRAULIC BALANCERS.

28, and this, too, is open to the same objection as regards disposition on the spindle.

It is usual to make hydraulic balancers with renewable faces at the points of close-running, so that the appliance can be readily repaired after wear has taken place. As regards the best material to be used for the renewable part, some considerable experience is needed before a decision can be made. Gun-metal was probably the first material to be used, but cast-iron, cast-steel, and hard bronze have all been tried, the present practice usually being to fit hard bronze. The ideal material is one which is hard and "short," and has a very low coefficient of friction when working in water; a material which "drags" is quite unsuitable, and apparently an incorrodible iron, one containing a high percentage of silicon or a nickel steel, seems to best fit the requirements. Non-metallic substances, such as red-fibre, woodite or dexine, have been considered, but any material which becomes slightly absorbent after long immersion is useless.

Sometimes difficulty is experienced in starting up large turbine pumps on account of the large diameter balance-rings being held together in metallic contact instead of being apart in their usual running position; the result is an abnormally high starting torque for the motor and probable damage to the faces of the balancing device. When a turbine-pump with differential balancer is "stopped," the rotor will always take up a position with the balancing faces apart if the waste-water outlet (Fig. 29), is taken to an open drain; however, if the spent water is led back to the suction pipe of the pump and a foot-valve is provided at the end of the suction-pipe, the whole rotor is forced towards the suction-end of the pump as soon as the foot-valve closes and the head pressure comes on. The reason for this is that the area of the balances on the outlet side is greater than on the inlet side by an amount equal to the diameter of the spindle. For this reason, the waste water from a balancer should not be connected to the suction-pipe of a pump, or means should be taken in the pump to equalize the areas subject to the static hydraulic pressure (Fig. 12).

IV.—The Rotor

As is well known, the internal design of a multi-stage turbine-pump involves a rotor comprising a number of impellers keyed on to a shaft, the shoulders or bosses of which abut on each other and are secured and maintained together by double nuts or the like at, or near, the ends of the shaft. Such portions of the shaft as are not covered by the impellers, but are subject to the action of the pumped liquid, are protected by sleeves which fit up to the impeller bosses and thus make a complete sheath outside the shaft itself, Fig. 1 (b), and Fig. 2 (a and b), etc.

This rotor revolves within the guide-chamber and housing, each impeller running at some points in the closest proximity to the partitions dividing the pressure-stages and return-guides.

These so-called running joints or neck-rings must be so maintained by design and construction as to secure in continued service the smallest possible hydraulic leakage-back from stage to stage, or mechanical loss by rubbing friction, both of which effect the efficiency and wear and tear of the pump. As a question of practical importance, the design of this combination probably follows next to that of the successful automatic hydraulic balancing of the axial end-thrust. We have in it the question of the deflection of the pump-shaft; the reinforcing effect of the surrounding impellers; the support afforded by the bushes, if any, between each stage, and the loss by bush friction (wear); the form of neck ring to reduce leakage; and the effect of keyways and keys, etc., all independent of each other and affecting the whole.

The ideal condition is that of a rotor supported in lubricated bearings with a shaft of such sufficient stiffness between supports that the deflection, under all possible running conditions, is less than the clearance allowed at the neck rings and intermediate bushes, so that no contact takes place between the rotating and the fixed members, this clearance at the neck-rings and intermediate bushes being kept down to the smallest possible limit. It will be seen that it is impossible to present mathematically, the exact conditions with such a number of incalculable factors to take into account.

For instance, it may be thought that a not inconsiderable reinforcing effect is obtained by the combination of the impellers outside the shaft as a whole. In practice, however, it is not advisable to lock up the impellers together shoulder to shoulder against each other by the

end-nuts in order to get the advantage of the reinforcing effect; because, due to, amongst other things, the slight inaccuracies of manufacture in squaring the shoulders of the impellers, sleeves, etc., the result would be to throw the combination out of truth, that is, to distort the shaft.

It might be contended that this need not be so, but even then provision must be made for dismantling in a mine or similar place, with its obvious attendant disadvantages, and the possibility of rough treatment taking place; furthermore, as a safeguard against heating up and consequent expansion of the outside combination (bronze) against the internal (steel) shaft due to accidental contact with the intermediate bushes, running, perhaps, when the pump is empty, suitable expansion should be allowed for, and the impellers, to ensure this, must not be locked tight against each other.

The supporting effect of the bushes on the shaft, in passing through the diaphragm intermediate between the impellers, is very difficult to exactly allow for; it may be that the bushes will decrease the deflection of the shaft by a material amount, but it must not be assumed for one moment that they are bearings of such a nature as lubricated bearings. Intermediate bushes can only, in some cases, be considered as water-lubricated supports which will act as such so long as a certain low surface pressure on them is not exceeded; if too great pressure comes on, heating takes place on account of the high speed of rotation. The effect of wear has also to be taken into account for the hydraulic pressures at the two ends of these bushes are different and there is, therefore, always a flow taking place through them, carrying with it any sedimentary or foreign cutting matter which may be in the water. This state of things causes the supports to wear more or less rapidly so as to become almost useless, the pump eventually arriving at a condition worse than if a suitable clearance had been allowed at the first.

The author believes that too much use is made of these intermediate supports in turbine-pump design. It is found in practice that an internal bearing to be successful must have the same water pressure at both ends, and must be properly lubricated with good grease, it then gives excellent results. We are thus left with the fact that we are practically dependent on the shaft itself for the necessary strength and stiffness to allow of fine internal clearance, and the importance of a good design which will economically give the minimum deflection of spindle at once becomes apparent. The factors affecting the deflection of a turbine-pump spindle are:—

Static

(a)—The weight of spindle and distribution of diameter change;

(b)—The weight and distribution of impellers, balancer, and parts;

(c)—The number and span of supporting bearings; and

Dynamic

(d)—In the dynamic condition, other incalculable forces entering into the account, such as, centrifugal forces due to the out-of-balance masses, and finally certain hydraulic disturbances.

(a)—Should be as light as possible consistent with the necessary stiffness; in common practice spindles are practically parallel the whole length.

(b)—Impellers and balancer should be grouped together as closely as possible, only allowing sufficient space for the water passages between the stages; also, the entire weight should be brought as close to the supporting bearings as possible.

(c)—The span of supporting bearings plays such an extremely important part in the durability of the pump; in the possibility and preservation of fine clearances; in the whirling of the shaft, and in the determination of the most economical size of spindle, that special notice will be taken of it.

(d)—A loaded shaft supported horizontally between two bearings will "sag," and when rotated must suffer bending at every revolution. Also, there are bound to be certain out-of-balance masses in the rotor due to keys, heterogeneous composition of material, and the unavoidable variation in thickness of castings, etc. In addition, a shaft has vibrational periods due to its length and diameter, the whole question of vibration being intensely complicated by the loading and supports.

In addition to the disturbing factors mentioned above, vibrations are set up from the reaction of the impeller vane passing the guide vane. It is usual to reduce the intensity of this disturbance by arranging an odd number of vanes in the impeller relative to the guide vane, and by setting successive impellers on the shaft in such a way that the point of passing-vanes is progressive throughout the series, i.e., a "lead" is given. The resultant of these arrangements is to produce a vibrating influence, which may be torsional or combined torsional and transverse, of very high frequency and enfeebled intensity and which, when properly carried out, is free from practical disadvantage. The damping effect of the water film in neck bushes is appreciable in overcoming slight vibrations, as is conclusively shown by the different behaviour of a spindle when running a pump dry and when running it filled with water. In order for a shaft to oscillate, it must force liquid out of one side of a neck-ring, and the retardation offered by this action has a noticeable effect. For this reason, quite apart from the lubricating effect gained, it is always a wise precaution to fill a pump with water before running it, otherwise if the shaft is not a stiff one seizing-up will probably occur. The remedy for spindle vibration due to any cause whatever is always a stiff shaft.

The whole matter of whirling shafts has been examined by several investigators, prominent among whom is Professor Dunkerley, but it is not proposed to discuss the matter further than to refer to the general proportions affecting the critical speeding of whirling. We find that the length (l) of span of bearings, and the diameter (d) of the spindle have an effect varying as:—

$$\frac{d^4}{l^3}$$

Turbine-pumps do not usually run at speeds approaching the critical speed, but the maximum safe speed for any rotor will bear a direct relation to the critical speed, in the sense that it will be an equal factor for equal safety. The above relation shows then, that for a fixed critical speed a reduction in the span of the bearings results in a material reduction in the necessary shaft diameter. The effect of axial thrust—always present in a turbine-pump—in lowering the critical speed of a spindle should always be borne in mind. With a view to consider-

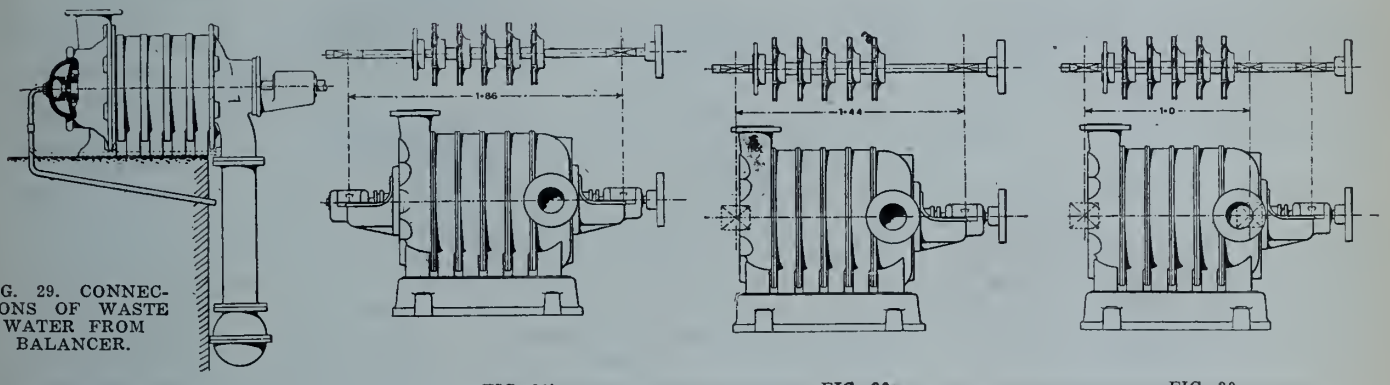


FIG. 29. CONNECTIONS OF WASTE WATER FROM BALANCER.

FIG. 30b. FIG. 30a. FIG. 30c.
SPAN OF BEARINGS—THREE ARRANGEMENTS.

ing the effect of the spindle diameter and span of bearings on the degree of fineness of the running clearances, we will examine the extent of the deflections. The following arrangements of bearings are possible and are illustrated in Fig. 30:—

1.—Two outside bearings.
2.—One outside and one inside bearing.
3.—One outside and two inside bearings.

A typical example was taken, and it was found, after drawing out the different arrangements, that the ratios of the spans of the bearings supporting the loaded shaft were, for the three cases, 1.86, 1.44, and 1 respectively, calling the shortest span unity.

As the deflection of a circular spindle is proportional to $\frac{l^3}{d^4}$, the deflections themselves for the above spans are proportional to 6.5, 3, and 1 respectively, or, the necessary sizes of spindles to maintain the same deflections are proportional to 1.6, 1.3, and 1. These results are conveniently tabulated:—

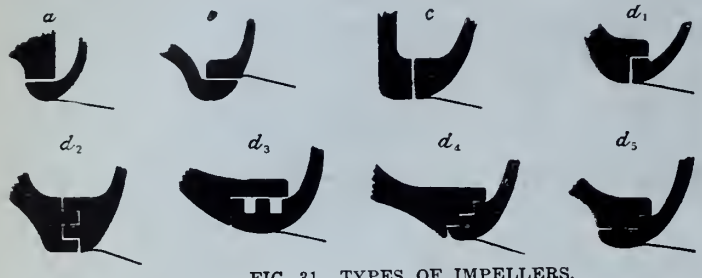


FIG. 31. TYPES OF IMPELLERS.

Case.	Ratio of span.	Ratio of deflections.	Ratio of spindle diameter to preserve constant deflection.
1. Two outside bearings. Fig. 30a	1.86	6.5	1.6
2. One outside and one inside bearing. Fig. 30b.	1.44	3	1.3
3. Two inside bearings. Fig. 30 c.	1	1	1

It will be noted that no allowance has been made for the buoyancy of the medium (water) in which the rotor revolves. The great importance of keeping the distance between bearings in a multi-stage turbine-pump as short as possible is aboundantly clear from the foregoing, for, with the more or less customary type, Case 1, Fig. 30a, with outside bearings at each end, it is seen we have a deflection of six and a half time that of a pump with two internal bearings. The direct result of this extra deflection is that the clearances between the outside of the eye of the impellers and the neck-ring must be increased to allow of the impellers revolving without touching, and this increased clearance necessarily means a correspondingly increased leakage and loss of efficiency.

Further, as has been shown, the passage of a large volume of water through the running clearance means increased wear and a tendency to push the walls apart, and therefore force the impeller and shaft still farther out of the straight with consequent friction against the adjacent neck-ring surface. Dynamic out-of-balance may, and, very probably, will exist, even though considerable care has been taken in the workshop to overcome it; this factor is a very important consideration, and calls for a very stiff shaft to resist its possible occurrence, because, if the shaft and impellers are thrown out due to this, then further clearance at the neck-rings is necessary or abrasion will result. The question of the reactive effect of an impeller discharging unequally round its circumference is capable of so many variations that the only practical way to overcome this also, is a mechanical construction that will resist deflection, that is, a stiff shaft.

There is a further disturbing influence which is more active in smaller pumps, namely, the effect of the hand-packed and often ill-adjusted stuffing-box and gland; this detail is always standard for one end of the pump, and sometimes found at both suction and delivery ends. Apart from the cutting effect of such a packing on the shaft or its sleeve, it also, by reason of its compression in screwing up, tends to set the shaft out of the true centre, and so may intensify many other similar influences. The risk of outside bearings, separate or overhung, being slightly out of centre, must also not be forgotten. For very many reasons, therefore, it is extremely important that the distance between bearings be kept as short as possible, and to do this successfully, internal, specially designed, large diameter, grease-lubricated bearings are essential. Summarizing the effect of a long distance between bearings, we have:—

(a)—Increased deflection of rotor.
(b)—Increased neck-ring clearance.
(c)—Increased leakage from delivery to suction.
(d)—Increased wear thereby, and
(e)—Decreased efficiency.

Turning now to the dimensions of the rotor, the table shows the diameter of the shaft does not increase as fast as the length of span increases. However, a very serious increase in size (1.6 times) is entailed by the increase in span consequent upon changing from two internal bearings to two external bearings. Obviously increasing the diameter of the shaft will give the decreased deflection desired, but then it introduces a larger diameter of impeller boss and entrance eye, thus bringing about a corresponding drop in efficiency as well as more leakage owing to the larger leakage area

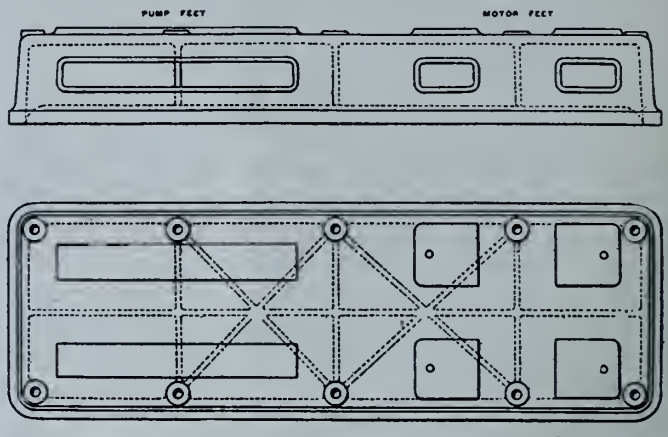


FIG. 33. BEDPLATE FOR "RING" TYPE OF PUMP.

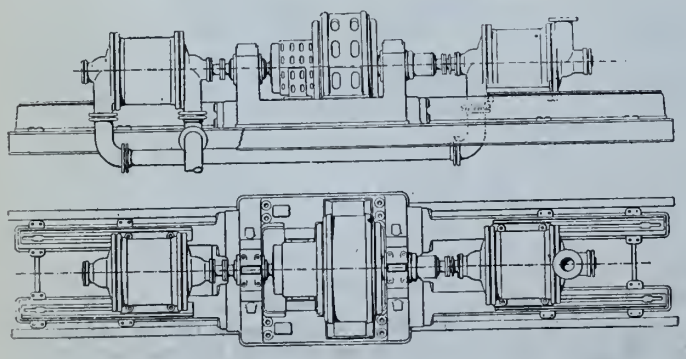


FIG. 32. BED FOR "CYLINDRICAL" TYPE OF CASING.

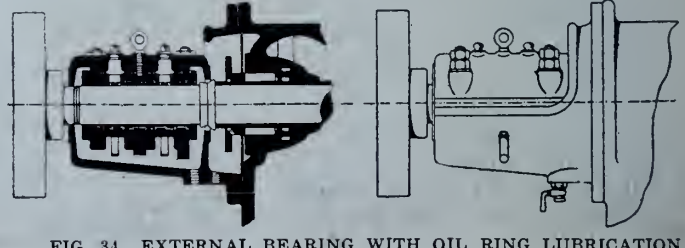


FIG. 34. EXTERNAL BEARING WITH OIL RING LUBRICATION.

consequent upon the increase in diameter of the boss and the neck-rings. It is clear, therefore, that securing the stiffness of a shaft by increasing its diameter is an inefficient method, for, besides the increased area for leakage through the neck-rings, we have much worse conditions of entrance in larger and more rapidly rotating eye and inlet edge of the impeller vanes.

The desirable condition, therefore, from all points of view, is to use the smallest diameter of shaft with the shortest distance between the bearings.

Leakage Between Rotor and Stator

The leakage through the neck-rings may now be considered under different conditions and clearances. The material of these rings is the first important consideration. It is obvious that a material should be adopted in the first place of such a type that it will not tend to drag or tear if accidentally touched or rubbed by the running impeller. Material of a hard "short" nature like cast iron will meet this condition, and in practice the smallest clearance can be successfully run with such neck-rings; they are, however, subject to corrosion, particularly with acid waters, as are frequently met with in mines.

The impeller, for the reason of susceptibility to corrosion, together with considerations of the necessary strength to resist the centrifugal effects of high speeds, is usually made from phosphor-bronze, we therefore frequently get in practice phosphor-bronze impellers running in phosphor-bronze neck-rings, though it is obvious that dissimilar metals would be preferable. A phosphor-bronze impeller with a cast-iron neck-ring is a better combination, and will run with smaller clearances, but to get over the corrodibility of the cast-iron it should be specially treated, or should be similar to that indicated for renewal balancer rings.

Soft metals will not run with fine clearances, for, if any rubbing is set up temporarily or otherwise, through dynamic out-of-balance, or want of alignment from any cause whatever, the metal immediately drags and the pump seizes up. The softer the metal the greater the clearance necessary. White-metal neck-rings have been tried, but were for this reason a failure. Lignum vitae is possible, but owing to its uncertain expansion, a liberal clearance allowance must be made; it provides, however, a material to meet special conditions (mostly stay-bearings in vertical shafts). Lignum vitae is also frequently used in water-turbines, tail-shaft bearings for ship's propellers,

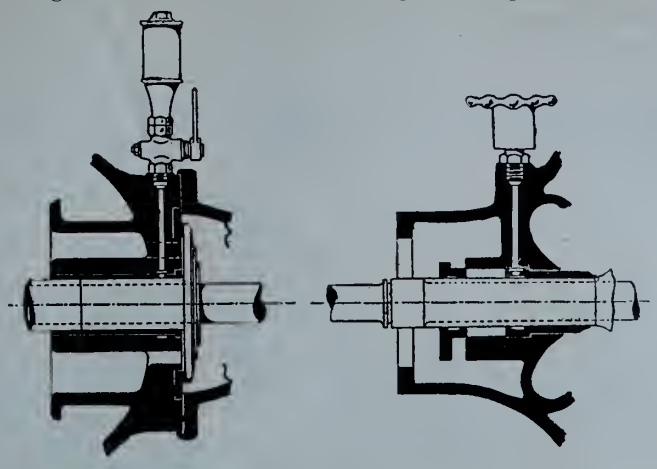
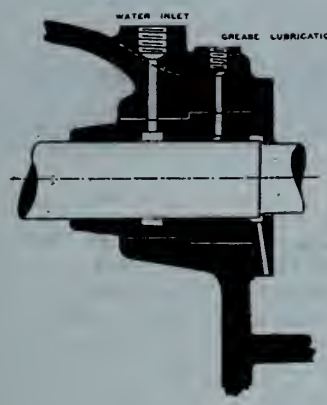


FIG. 35. INTERNAL GREASE-LUBRICATED BEARINGS.



etc. The form of the neck-ring is, in practice, confined to four forms:—

(a)—Internal.
(b)—External.
(c)—Vertical.
(d)—Labyrinth.

Types of which are illustrated in Fig. 31

The first is the usual form in turbine-pumps, the second is more rare, the third is practically restricted to single impeller low-lift centrifugals, while the fourth is a refined form after steam-turbine practice, and is used in some high-lift pumps.

Between (a) and (b) there is little to choose, but for manufacturing reasons, (a) is usually preferred. Clearances of a few thousandths of an inch per side can be run with a suitable shaft, and the leakage is very slight, less than 1 per cent.

(c)—The vertical form is used in pumps for low lifts subject to dirty water and inferior attention. It allows of downward wear of the impeller without any rubbing surface coming in contact with (a) and (b) would not. (d) is an attempt to reduce leakage further by a device of the kind used on the steam-turbine.

For the reason that the labyrinth type deals with a non-expansible fluid like water, and not steam, it is far less effective than in the steam-turbine, and in fact can only restrict leakage by the formation of eddies in the channels or grooves; shock losses at the sudden changes in area and direction, and the centrifugal effect of the rotating film of water in the narrow aperture. Its possible advantages in this way are more than negatived by its fragile nature if it comes in contact with the impeller, such a contingency usually involving the eventual renewal of both parts. Types (a) and (b) only require a new neck-ring for after war. All types, however, are readily made with loose rubbing rings which may be easily changed.

In practice it has been found that when grooves were cut on the impeller-shoulders to secure a labyrinth effect, and at the same time the neck-rings were left plain, that after running for some time the marks of the grooves were always found on the neck-rings; the difference between the worn surface and the original surface often being as much as ten thousandths of an inch, showing in these cases a deflection of the shaft greater than the calculated value. In these particular cases the fact that the grooves appeared all round the ring to the same depth, indicated that they were due to actual deflection and not faulty alignment, the reasons for which may be found in the causes already enumerated and in mechanical inaccuracies.

When interlocking grooves are used, the difficulties of erection and dismantling are increased unless the interlocking is in the plane at right angles to the axis of the pump; any other arrangement is of course only possible with horizontally split pumps or with split or divided neck-rings.

FIG. 36. HAND-OPERATED GREASE LUBRICATOR.

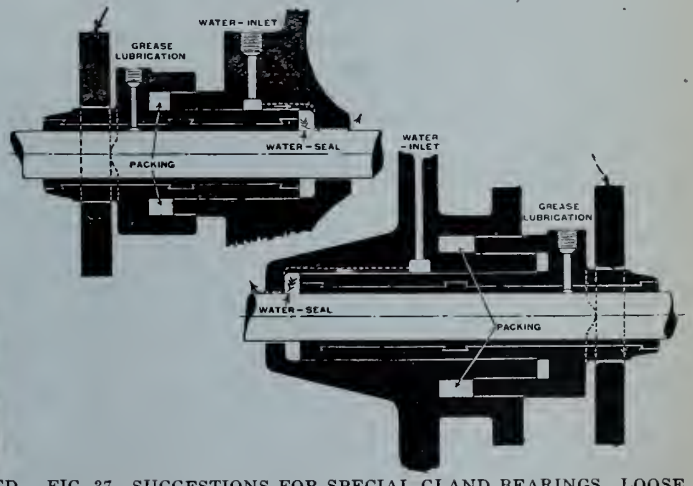


FIG. 37. SUGGESTIONS FOR SPECIAL GLAND BEARINGS. LOOSE FLANGE BEARING ON TWO ROUNDED POINTS ONLY.

V.—The Bed and Other Details

In the past, less importance has been placed in the effect of the bed-plate than is now the case, with the result that fre-

quently very shallow depths were used. These early beds were much too weak to resist warping strains due either to the unevenness of the foundation surface, the "pull" of holding down bolts, or tc the reaction of the torque from the motor-end. It was a common practice to design bed-plates in the form of two separate horns or branches, and in this case deeper sections were generally employed. This form of design while undoubtedly stronger against bending depends too much upon the skill of the plant erector and the solidity of the foundation to always give good results.

It must be obvious that if fine internal clearances, such as have been dealt with, are an advantage, then the common base for the lot—the bed-plate—must be of a nature to ensure the clearance remaining concentric and also to maintain true alignment with the operating motor. For these reasons deeper sections than are usual are an advantage.

With the "ring-type" of casing the bed-plate plays a more important part than with the "cylindrical" type on account of the lesser intrinsic rigidity of the contiguous type and the greater necessity for a plane true surface in erecting; hence the importance of deeper sections becomes more pronounced still. It is now customary to have supporting feet on each "ring" of a multi-chamber pump, probably more for the convenience of re-erection in awkward situations than for any necessity for actual support. Chambers, when dismantling or re-erecting, require to be slipped along the spindle and bed, and for this reason it is usual to machine the latter for its full length.

An example of substantial base-plate provision for a "cylindrical," casing is shown in Fig. 32, and a bed as recommended for a "ring" casing pump is shown diagrammatically in Fig. 33; in cases where there is a heavy torque from the driving motor, diagonal ribs as shown are most valuable in resisting twist on the bed.

Bearings

The almost "standard" speed of 1,450 revolutions per minute for operation of turbine-pumps does not require water-cooled bearings. For outside bearings good design oil-ring lubricated type as shown in Fig. 34 are used, a recommended feature being the provision of a thrower or guard to prevent water from a leaking gland entering the oil well and washing out the oil.

As has already been stated, to keep the distance between shaft supports as short as possible involves the use of internal grease-lubricated bearings, typical designs of which are shown in Fig. 35. This type of bearing, when carefully designed, can be made to operate very satisfactorily in practice despite a contrary view held for some time by some constructors. The important point of arranging for similar hydraulic pressures at each end of an internal grease-lubricated bearing, so as to prevent any risk of flow through the bearing surfaces, must be rigidly followed for best results.

The charging and supplying of grease to internal bearings requires proper lubricators. The ordinary "Stauffer" is unsuitable, though generally a hand-operated appliance of simple design (such as Fig. 36) meets the case; a long trumpet-shaped entrance is essential in order to force against the high pressure due to the head of water against which the pump is working. The selection of a good quality grease lubricant suitable for operating in water plays an important part in the satisfactory lubrication of a bearing.

Stuffing-Boxes

It is doubtful if we can accept the customary stuffing-box and gland as good and satisfactory practice. The functions of ith sdetail are on the suction or vacuum end to prevent air-leakage into the pump, and on the delivery end to prevent pressure leakage from the pump. The action of "packing" on rapidly rotating shafts is so severe as to demand the omission of a stuffing-box wherever possible. On the delivery end of a pump it is easy to avoid a gland either by closing-in the spindle (Figs. 3, 23, and 25), or by so reducing the pressure in passing through an hydraulic balancer that there is no pressure against which to pack (Figs. 4, 12, and 13).

Some constructors have done without stuffing-boxes at both ends of the pump for some time, and they generally rely on pressure water from the pump itself supplying the necessary packing to prevent access of air to the suction inlet. The possibility of difficulty in starting up a pump before the water packing is available should be carefully considered when this method is adopted.

Suggestions for the substitution of a special form of grease-lubricated, gland-bearing without any packing in contact with the rotating spindle, are shown in Fig. 37. Though these bearings are not arranged with end pressure in equilibrium, there is no tendency for water to pass over the bearing surfaces as leakage will take place from the water sealing ring to the reduced pressure of the suction inlet.

BOILER SETTING BRICKWORK

GENERALLY speaking, brickwork will stand without cracks in boiler settings unless it is pushed by the boiler; and it is only necessary to so place it, and have such details about the boiler, that it will not receive any serious pushing. The brickwork should not touch the boiler anywhere, and the space between should be stuffed with asbestos fibre. Although this filling may tend to leak air, the covering over the top of the boiler, which rests on the brickwork, prevents this. The front end of the boiler should be fixed, and the other end should have attached to it some back connection covering which will slide and not tend to push the back wall over.

Boiler Sides Brickwork

The vertical thickness of the brickwork on the sides of the boiler, and almost in contact therewith, should not, says F. W. Dean, be more than 12 in. It has been made 24 in., and in such cases I have seen the part raised bodily, apparently by the expansion of the boiler. This part of the brickwork is usually above the centre of the boiler, but it should be equally above and below the centre as thereby there is less chance of any of its weight being supported at all by the boiler. If the boiler supports it there is a chance that its weight will bend the plates, and the arguments against this have already been given.

It is customary to build the side and back walls of boiler settings with air spaces in order to diminish loss of heat by radiation. That these spaces cause loss of heat by convection and leakage, is probable, and it has been proved by experiments carried out by the United States Bureau of Mines (Bulletin 8) that this is true. If it is advisable to use spaces in the walls in order to prevent cracking of the brickwork, it is best to fill them with some material, such as ashes, crushed brick, sand or other loose material, which will entrap air but diminish its movement. Solid brick walls form a better non-conductor than walls with air spaces.

HIGH VACUUM CONDENSERS

IN purchasing high vacuum condensers, comparison should be made of the pneumatic resistance of the structures on the basis of velocity of flow at each row of tubes and the number of rows in series through which steam must flow. Attention should also be given to possibilities for the formation of air pockets out of the line of flow, considering both transverse and longitudinal sections.

The highest coefficients of heat transmission are obtainable in condensers of moderate size in which the smaller depth of tube bank lessens the pneumatic resistance.

The depression of the air suction temperature below the inlet vacuum temperature is an index of the surface efficiency on the steam side.

By analyzing the temperature depression in a given condenser into that due to pressure drop and that due to partial air pressure, it is possible to determine whether flow conditions or air conditions offer the greater possibility for improving efficiency and vacuum.

By means of accurate electrical resisance thermometers, temperatures can be taken at a multitude of points on both steam and water sides of the surface of a condenser undergoing changes in operating conditions, which would enable one to isolate the factors influencing the extent of the active and inactive zones.

A high velocity of circulating water, or the equivalent increase in water film agitation by the use of cores or spirals, is desirable in the tubes of the active zone of a condenser, and this can be obtained, without additional power consumption in pumping the circulating water, by reducing the velocity of the water through the tubes of the inactive zone.

Power Plant of the CANADIAN KODAK Co. LTD

Mt Dennis, Nr. Toronto, Ont.

STAFF ARTICLE.

Photography has long since been recognized as a public necessity in addition to its practice having become one of our most fascinating and enjoyable pastimes. The manufacture of the wide range of photographic apparatus and supplies with which all of us are more or less intimately acquainted calls for an equally wide and extensive range of high grade factory equipment, and this is specially true of the section of the latter to be found in the power plant department; a pertinent example constitutes the subject matter of this article.

AT Mount Dennis, Ontario, a village situated within a short distance of Toronto, the Canadian Kodak Co. have established their factory and head office. The site and immediately adjacent district are now known as Kodak Heights and from this it may be inferred that the district is high, dry and healthy. It is in many respects an ideal location, being within easy access of Toronto, and having good transportation facilities, also a plentiful supply of water. The site being more or less irregular in contour lends itself to artistic treatment, the grounds have therefore been laid out accordingly. When the trees and shrubs, etc., have grown, it will be, without doubt, one of the most attractive factory establishments in Canada. The site covers twenty-five acres and is located on the Canadian Pacific and Grand Trunk Railways. The main factory and office building stand on the level ground, the power plant being on a slope on the east side. Further along at the bottom of the slope is a reservoir. Provision has been made for future extensions; in addition, a considerable area has been appropriated for recreation grounds, the latter including baseball and football fields, bowling green, and tennis courts.

Building Construction and Layout

The plant is modelled after the Eastman Kodak Co., factory at Rochester, N.Y., being approximately one-tenth the size of that of the parent concern. All the buildings with the exception of the power house, which is of steel frame and brick walls, are constructed of reinforced concrete. Before commencing construction, bearing tests were made of the soil and a safe pressure of one and one-half tons per square foot established. The greatest care was taken during construction in securing only high-class materials, tests being made of the cement and reinforcing steel. Test cylinders were also taken of the concrete from the mixer at regular intervals. Beam girder construction has been employed, with interior partitions of hollow tile and fire walls of brick. Steel sash is used throughout. The roofing consists of 4 inches of cinder covered with cement finish and five-ply tar and slag roofing. Fire escapes are provided as well as stairways of the stair tower type. The main office building contains lunch rooms and is separated entirely from the main factory structure, access, however, can be obtained by means of a tunnel.

BOILER ROOM, SHOWING "BABCOCK & WILCOX" WATER-TUBE BOILERS EQUIPPED WITH "MURPHY" STOKERS

Power Plant Building

The power house is of steel construction with brick walls, and is located in the rear of the main building. It is 235 ft. by 60 ft., and is divided into three sections, containing respectively the engines and generators, refrigerating machinery, and the

EXTERIOR VIEW OF BOILER HOUSE. WATER SOFTENER AND STEEL TRESTLE FOR COAL CARS.

boilers. The boiler room floor is 35 feet below the first floor level of the factory building. In laying out the power plant, provision was made for a 100 per cent. increase in equipment. An advantage is gained by having the boiler room floor on the low level as it allows coal to be brought, from the railways on to a steel trestle, from which it is dumped from the cars into a 600 ton concrete bunker located directly over the boiler furnaces.

Boiler Equipment

The boiler installation consists of four 320 horse power Babcock & Wilcox water-tube boilers of standard construction but with vertical headers. Each boiler has 3014 sq. ft. of heating surface, and carries a working pressure of 125 lbs. per sq. inch. When erecting the boilers, particular attention was paid to laying the fire brick and outside boiler walls. The bricks were dipped in mortar before being laid, thus making practically a brick to brick joint. With this method of construction there is less liability of the boiler walls giving way under the tension of the stoker arches. The boilers are equipped with Murphy automatic, smokeless, mechanical stoker, furnaces, from which the ashes fall directly into a hopper below and are drawn off into small hand cars in the ash tunnel underneath. These hand cars are picked up by a one ton Sprague hoist and deposited in an overhead concrete bin. The chimney is of the radical brick type and is 200 feet high. The boiler feed water is obtained from the reservoir which is fed by three artesian walls. Before being used, the water is passed through a Kennicot water softener which has a capacity of 6,000 U.S. gallons per hour. The boiler feed is taken care of by two 10-6-10 ins. Worthington duplex, outside packed, pot valve, plunger pumps. Before being delivered to the boilers, the feed water is passed through a 1500 horse power heater using exhaust steam at 3 pounds pressure.

The factory is heated by exhaust steam at 3 lbs. pressure. All the steam piping for heating and factory purposes electric light and power conduits, cold water piping, etc., are laid in a concrete tunnel which runs underground from the power house alongside the factory exterior. The tunnels range in size from 9 ft. by 8 ft. to 4 ft 6 in. by 4 ft. 6 ins. Two 10-14-18 ins. Blake-Knowles single vacuum pumps capable of taking care of 80,000 square feet of radiation are installed in connection with the heating system. All the low pressure steam lines are fitted with steam traps.

In the engine room are installed three generating units consisting of a 350 k.w. Corliss engine and Canadian Westinghouse generator; one 150 k.w. Harrisburgh steam engine with generator and a 65 k.w. 14 x 14 in. steam engine built by Goldie & McCulloch, Galt, and direct connected to a Bullock generator running at 235 r.p.m. The first mentioned unit is new while the other two were removed from the old factory on King Street, Toronto. The new unit is an Inglis horizontal, cross compound, heavy duty, Corliss engine having cylinders 18 in. and 30 in. by 30 in. stroke, running at 150 r.p.m. It is direct connected to a 300 k.w. Canadian Westinghouse 3-wire, 125-250 volt, d.c. compound wound commutating pole type generator. The engine operates on a steam pressure of 150 pounds with 5 pounds back pressure. The valve gear is operated by double wrist plates set for long range cut-off, the governor controlling both high and low pressure cylinders. The fly wheel is 11 feet diameter and weighs 22,000 pounds.

The switchboard which was supplied by the Canadian Westinghouse Co. has

150 K.W. "HARRISBURG," AND 65 K.W. "IDEAL" ENGINES, WITH ALLIS-CHALMERS-BULLOCK GENERATORS.

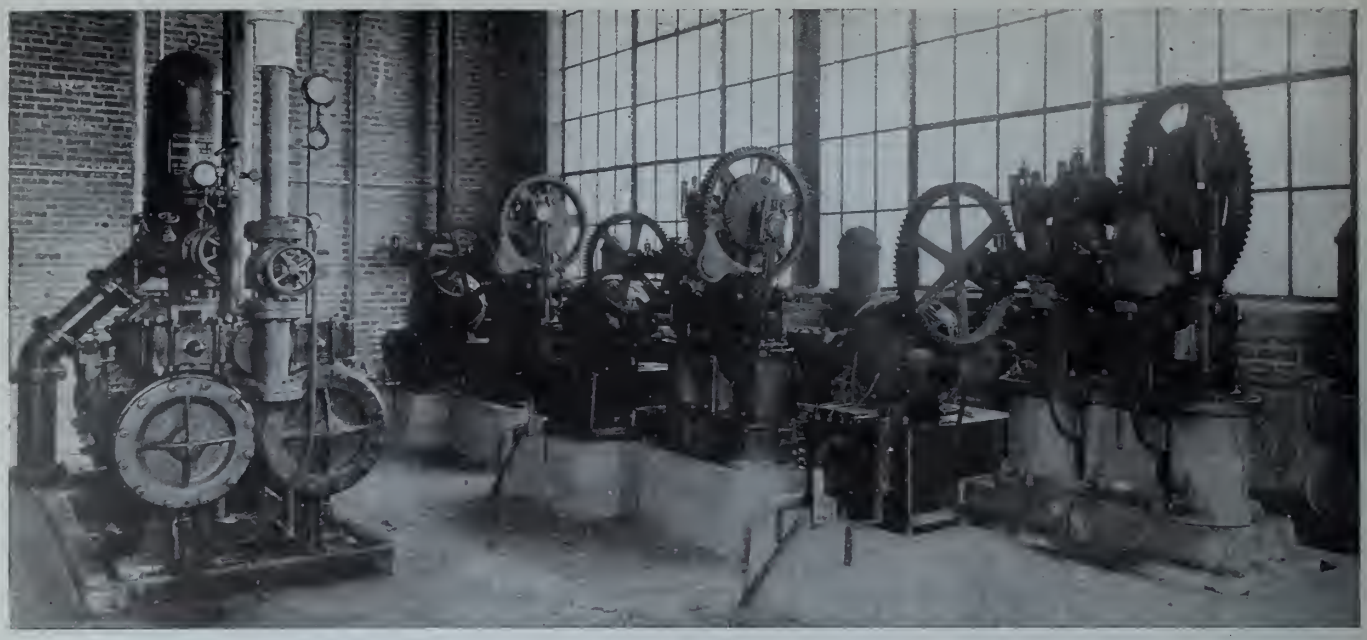
six black marine finish slate panels, 90 ins. high and 24 ins. wide. Each panel is divided into three sections, the top slab being 20 ins., the middle, 45 ins.; and the bottom slab, 25 ins. deep. The first panel controls the 62 k.w. generator; the second panel, the 150 k.w. generator; while the third panel controls the 300 k.w. unit. The fourth, fifth and sixth are feeder panels. Each feeder is supplied with a pair of carbon circuit breakers and a Sangamo watt-hour meter. There are two volt meters on a swinging bracket at the end of the switchboard. All cables have flame-proof insulation and are run from terminals at the bottom of each panel down through a slot in the floor. They are supported by porcelain clamp insulators between there and the generators. Cleats are fastened on underside of floor between the switchboard and generators. The feeder cables are carried in the same way through the tunnel between the power plant and factory already referred to. In the factory there are approximately 148 Fairbanks electric motors of 230 volts, d.c., ranging from ¾ to 25 horse power.

The refrigerating system is an important feature at the Canadian Kodak Co. factory, the new unit about to be described being the largest single acting ammonia compressor installed in this country. The total capacity of the refrigeration plant is 390 tons, the main unit being a 200 ton vertical ammonia machine consisting of two vertical, single acting compressors, each 21 in. bore by 32 ins. stroke, and equipped with safety heads. The discharge end of the compressors is water-jacketed, and the suction end insulated with "'nonpareil" cork. Each compressor is equipped with indicator connections and pressure relief valves in heads, while the stuffing box nuts are operated by hand wheels geared from same, so that they can be adjusted by the engineer standing on the floor. Each compressor is direct-connected to a horizontal cross—compound Corliss engine, the high pressure cylinder of which is 20 in. by 32 in., and the low pressure 38 in. by 32 in. Each steam cylinder is equipped with force feed lubricator, hand oil pump, indicator connections, and two relief valves. The piston rods are of nickel steel. The pistons have metal wearing rings in addition to the packing rings. Each machine is packed throughout with metallic packing, in addition it is fully equipped with the requisite accessories, including nickel-plated revolution counter with 10 in. dial, and a central oiling system. The compressors have a capacity of 200 tons of refrigeration in twenty-four hours when operating at 185 pounds condensing pressure, 20 pounds suction pressure, and 65 r.p.m.

GENERAL VIEW OF "KODAK" PLANT FROM THE WEST. FACTORY BUILDINGS ON LEFT, MAIN OFFICE BUILDING ON THE RIGHT, AND POWER HOUSE BEYOND.

The compression side consists of eight of the latest type double pipe, flooded ammonia Shipley condensers, made up of 2 in. and 3 in. piping, 18 feet long. These condensers are equipped with a purge drum for collecting the foreign gases, and have washout connections for the water tubes in addition to the regular water and ammonia valves and connections. The ammonia receiver is 3 feet 6 in. in diameter and 16 feet long, and the high pressure oil separator is 2 feet in diameter and 8 feet long. Both are wrought iron welded shells of standard construction. A check valve is located in the 5-inch discharge line between the compressor and the condenser. The evaporation side of the plant consists of water coolers and brine coolers, located in the room adjacent to the engine room, from which the water and brine are pumped to the different points

GENERAL VIEW OF ENGINE ROOM, SHOWING 300 K.W. "INGLIS" CORLISS ENGINE, AND CANADIAN WESTINGHOUSE GENERATOR IN FOREGROUND; "HARRISBURG" AND "IDEAL" ENGINES AT REAR.

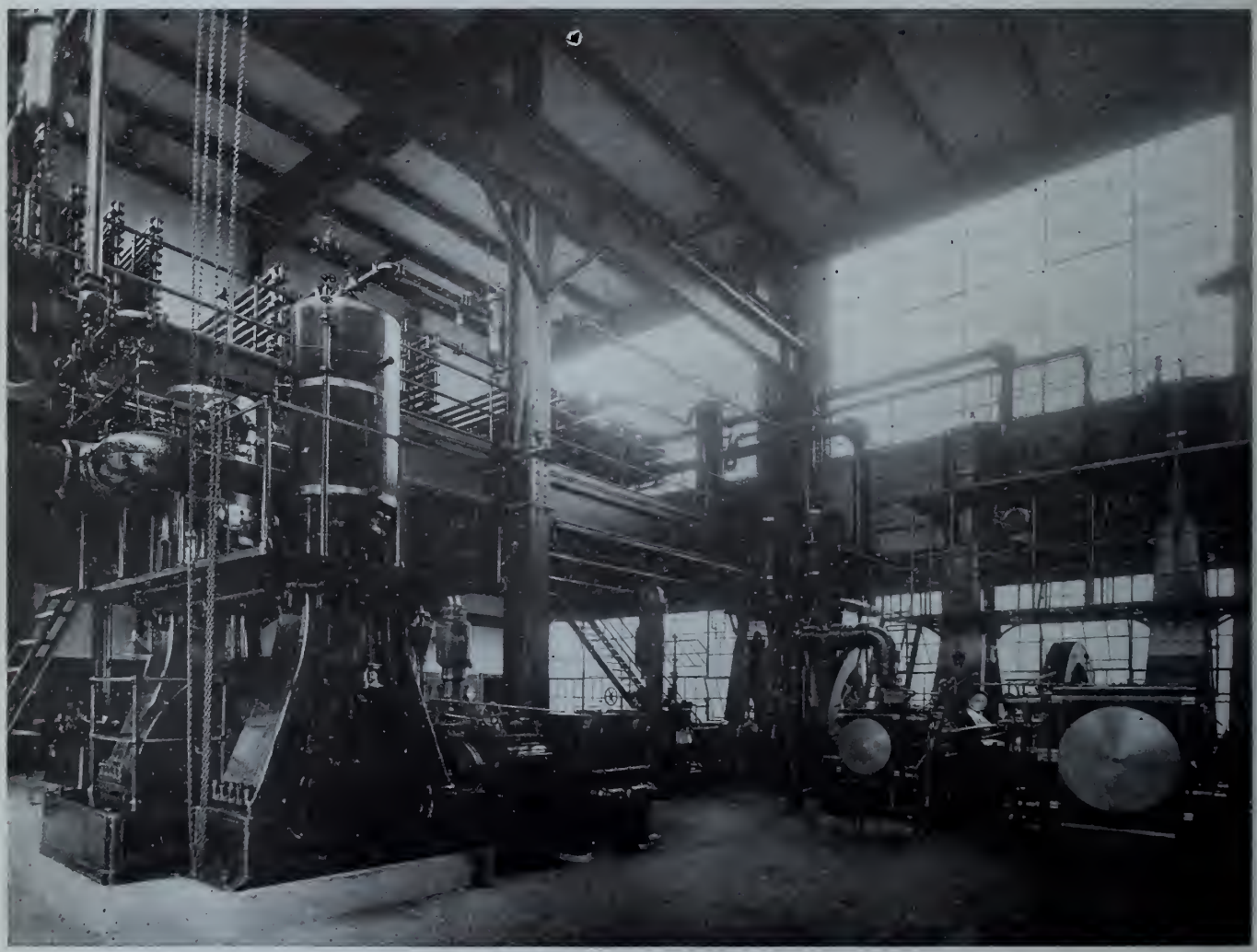


PART OF PUMPING INSTALLATION WHICH COMPRISES A CANADA FOUNDRY CO. "UNDERWRITER" FIRE PUMP; TWO "GOULDS" 3" x 10" TRIPLEX, COLD WATER CIRCULATING PUMPS, AND ONE "GOULDS" 10" x 15" TRIPLEX, BRINE PUMPS.

in the factory where the refrigeration is required.

Water Cooling

Water cooling is accomplished by means of twelve stacks of water cooling coils, arranged in two batteries of six stacks each. Each stack is made of 2 ins. galvanized ammonia pipe, twelve pipes high and 20 feet long, equipped with water distributing trough and galvanized iron splash strips between each pipe. Each battery of water coolers is equipped with oil drains and collecting tank, and the suction gas passes through a trap or accumulator which separates



REFRIGERATING PLANT, SHOWING 65-TON "YORK" COMPRESSOR ON LEFT; 125-TON "DE LA VERGNE" MACHINE WITH "YORK" COMPRESSOR IN CENTRE, AND 200-TON "YORK" MACHINE ON RIGHT. SHIPLEY CONDENSERS ARE ON MEZZANINE FLOOR ABOVE.

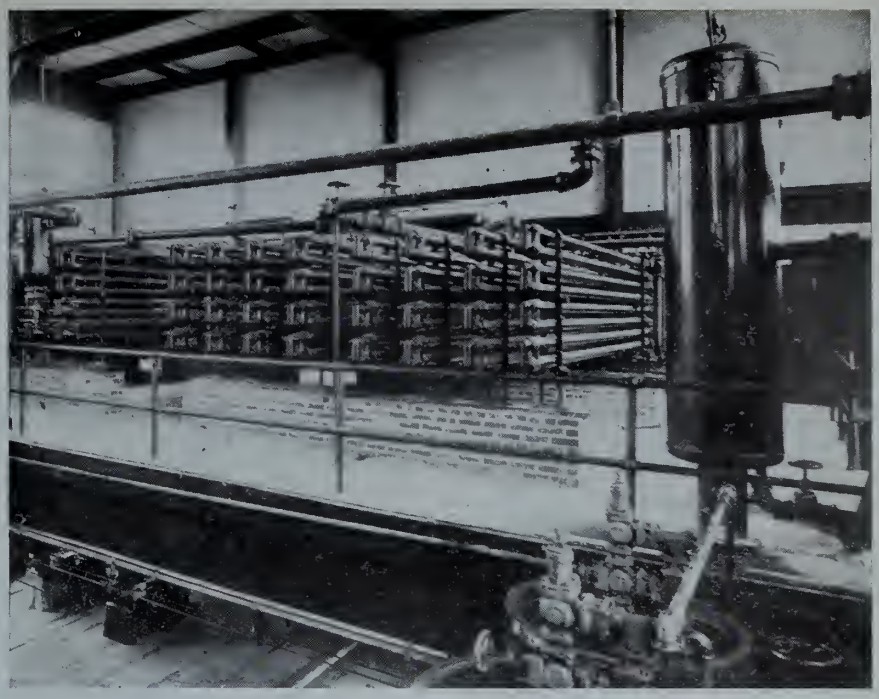
any liquid ammonia before it passes on through the main 30 ins. by 10 ft. scale trap in the suction ammonia line near the machine. By means of these various traps, the gas is bound to reach the ammonia compressors in a slightly superheated condition—which insures the machine operating at the very highest efficiency, at the same time enabling the cooling coils to be flooded with ammonia so that they also work at their maximum efficiency.

Brine Cooling

The brine cooling is accomplished by means of two York shell and tube type horizontal brine coolers, one 51 ins. in diameter by 16 feet long, the other 39 ins. by 12 feet long, with location provision for future coolers on the floor above the water cooling room.

The brine storage tank has a capacity of thirty thousand gallons, and is located on the floor above the brine coolers. Two 500 gallons per minute brine circulating pumps are located in the basement three floors below the brine tank, and one floor below the machine room. Eight-inch brine mains connect them to storage bank, brine cooler and cooling system.

The water cooler room, brine cooler, brine tank, brine mains, and all exposed cold ammonia mains are insulated with 'nonpareil" cork. The cold water circulating pumps and brine pumps are of the triplex type, each pump being direct connected to its own motor. The water for ammonia condensing purposes is cooled by means of an atmospheric type water-cooling tower on the roof of the main building. The water is circulated over this tower through the condensers by means of two Goulds centrifugal pumps direct connected to motors, each having a capacity of 500 gallons per minute.

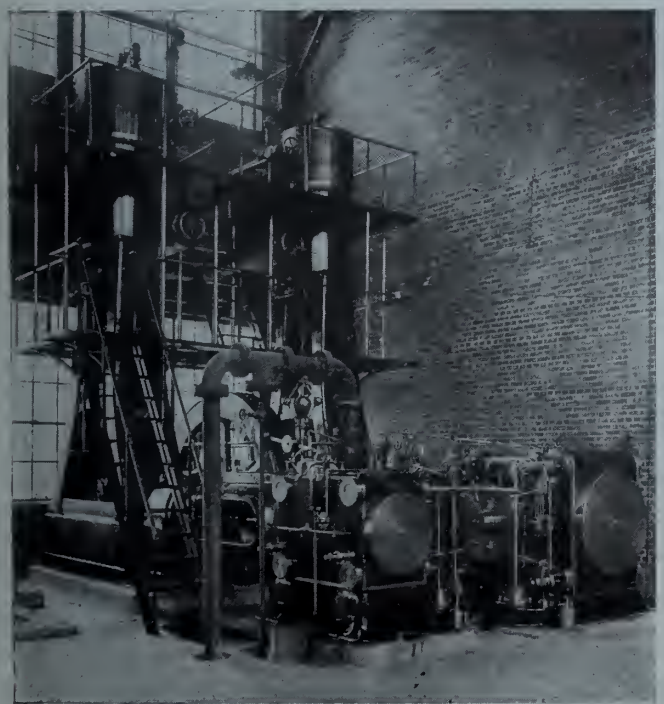


"SHIPLEY" DOUBLE PIPE FLOODED CONDENSERS ON MEZZANINE GALLERY.

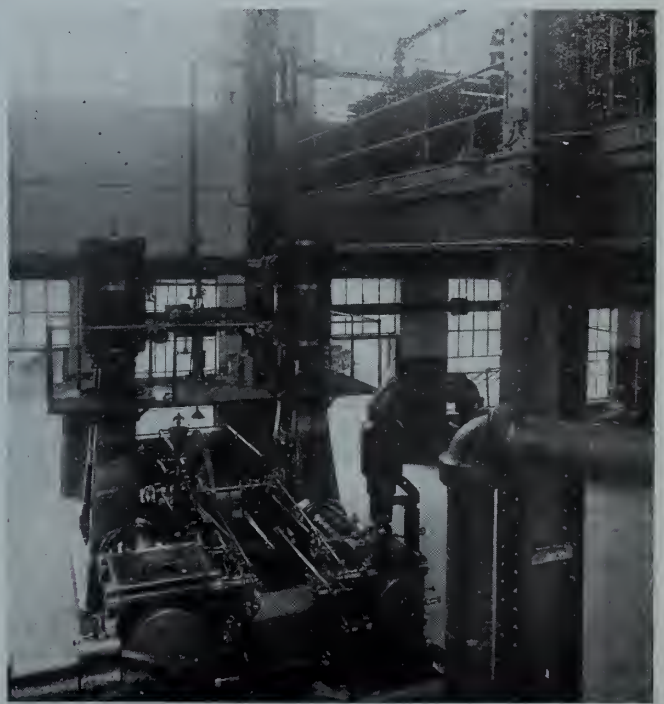
In addition to the new equipment described, there is a York 14 by 21 ins. vertical, single-acting compressor, direct connected to a 14 by 26 by 21 ins., cross compound, Corliss engine, and a vertical De La Vergne machine equipped with York 18 by 28 inch ammonia compressor of 125 tons capacity. This machine is direct connected to a horizontal simple Corliss engine. These units were moved from the old plant. The compression side for these two latter consists of eight stacks of standard counter current double pipe ammonia condensers, and five stacks of flooded double pipe ammonia condensers, with all necessary high pressure traps, receivers, etc. These are cross connected to the new unit and are arranged so that any one machine can be used on any or all of the condensers, either together or separately.

General

Two Northern hand operated cranes are installed, one in the engine room having a capacity of 15 tons, and a span of 49 ft. 3⅛ ins., while the other crane in the compressor room has a capacity of 15 tons and a 27 ft. 8 ins. span. Both cranes are rope drum, hand power type, designed for power station service, and are operated from the floor. The hoist



200-TON "YORK" VERTICAL, SINGLE-ACTING REFRIGERATING MACHINE, COMPRESSOR CYLINDERS, 21 INS. DIAMETER BY 32 INS. STROKE.



65-TON "YORK" VERTICAL, SINGLE-ACTING REFRIGERATING MACHINE. COMPRESSOR CYLINDERS 14 INS. DIAMETER BY 21 INS. STROKE.

has two speeds, the bridge and trolley, both being geared for travel by hand chains. The gearing is all of cut type, and the axles are fitted with roller bearings.

All the brine and chill water lines are carried from the power house to the various buildings through the underground tunnels already described. An 80,000 gallon closed-in concrete reservoir has ben constructed for providing pure water for drinking and factory purposes. The reservoir is supplied from three artesian wells as already stated. The overflow from this reservoir goes into a 75,000 gallon open concrete reservoir which supplies the boilers. A 25,000 gallon steel tank supplies water for general factory purposes.

BRUSH-HOLDERS FOR SLIP RINGS

BRUSH-HOLDERS for metal graphite brushes take forms both foreign and akin to direct-current holders. With these holders the brushes require the usual multiplicity of expensive shunts, the necessity for which, with a proper holder, is at least debatable. Inasmuch as slip ring brushes may be placed indiscriminately around the rings, there is no occasion for maintaining a fixed brush relation to the rings. The ideal holder, therefore, may be in the development of the swivel type, in which the brush may be clamped in the box and the brush itself requires no shunt. The box should, however, be heavily shunted to the holder support in order to protect the swivel from possible arcing due to the current passing through the swivel joints. The brush will require occasional readjusting in the holder due to the wear of the brush reaching, from time to time, the travel limit of swivel. (This limit should not permit the holder to come in contact with the ring). This requirement, however, will not approach the work involved in trimming copper leaf brushes, or in cleaning the accumulated dust from between the brushes and holders, as is necessary with present holders.

At the present time a few slip ring motors are being fitted with a holder of the foregoing type, but the value of its general application has not been fully determined. Present holders are designed to take single brushes, or two brushes side by side, or two brushes in "tandem." The last-named holder is the least desirable for the reason previously stated. However, it has the advantage of economizing the space around the ring and to a degree precluding congestion. Its single objection can be readily overcome by using a partition between the brushes.—Electric Journal.

HANDY CHART FOR ESTIMATING PULLEYS, FLYWHEELS, ETC.

By "Woodworker."

HERE is a chart that will come in handy in a number of ways wherever circular motion is to be computed or estimated. Knowing any two of the factors shown in columns A or B, the third can be found.

For example, a 20-inch pulley makes 600 revolutions per minute. What is the speed of the pulley periphery in feet per minute? This is a very common problem.

Find the 20 (column B) and the 600 (also in column B), and then locate the point half-way between them. This is done by folding a strip of paper, by means of a pair of dividers, with a ruler, etc. There are many good ways in which to find a mid-point. Directly opposite that mid-point is the answer—very close to 3,200 feet per minute.

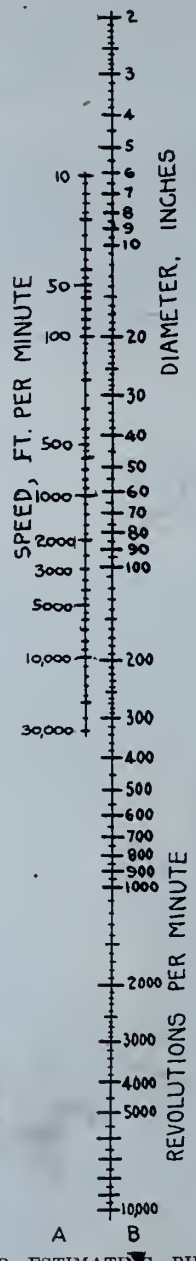


CHART FOR ESTIMATING PULLEYS, FLYWHEELS, ETC.

This answer is not exact, of course, nor does a slide rule give an absolutely accurate answer, but it is close enough for most practical purposes. The designer is generally most anxious to keep well within the bounds of safety. Well, 3,200 ft. per minute is a safe speed for almost any pulley. In fact, a mile a minute is usually given as the maximum speed for wood pulleys, cast iron pulleys, and others of a brittle nature. Steel pulleys are often allowed to run at 6,000 to 7,000 ft. per minute, and in extreme cases even that speed has been beaten, but nobody should ever attempt a greater speed than a mile a minute without being absolutely sure of himself, his calculations, his design, etc. It has often been pointed out that the energy stored in a flywheel sometimes reaches stupendous proportions and when a flywheel explodes we all know the attendant results.

Again, when it is desired to determine the approximate number of revolutions per minute at which a given pulley will run when the diameter and belt speed are known, the chart is used in this way:

Take the same example as above. Let us assume that the diameter of the pulley is 20 inches and the speed of the belt 3,200 ft. per minute. What will be the r.p.m.?

Find the distance between the 20 (column B) and the 3,200 (column A), and measure that self-same distance downward from the 3,200, and there's the answer in column B = 600 r.p.m. This method is just the inverse of the first, of course.

Lastly, if the speed in feet per minute is known and if the r.p.m are known, the diameter in inches of the required pulley is found by following the same tactics as in the last example. Using 600 and 3,200 as known quantities, the answer will be found to be 20 inches.

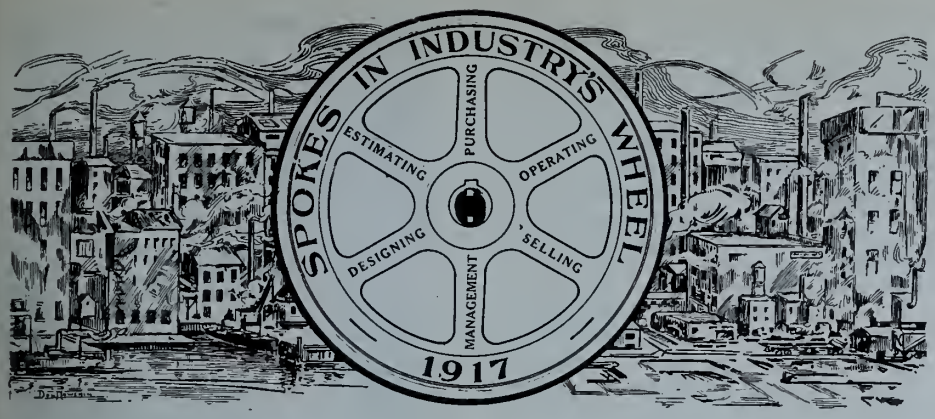
In metal turning, also, this chart will be found useful for determining cutting speeds. Knowing the diameter of the stock and the r.p.m., the cutting speed is found as in the first problem cited here. If the diameter is 1 inch, use the 10 on the chart and mentally divide the answer by 10. If the diameter is 1.5 inches, use the 15-inch mark, and again mentally divide the answer by 10. It is thus evident that the range of the chart is virtually unlimited.

ADDITIONAL AIR OVER FUEL BED

ADMISSION of air into the boiler furnace through leaks in the furnace wall is undesirable and should be avoided.

The ideal way to supply additional air over the fuel bed is to introduce it as close to the latter and in as large a number of small streams as possible. The nearer the air is introduced to the surface of the fuel bed, the more combustion space is utilized for mixing air with the combustible gases and for burning the mixture. A large number of small streams of air entering the furnace facilitates mixing the air with the combustible gases, particularly if it is forced in at high velocity. When the air is introduced in one large stream at low velocity it tends to flow parallel to the stream of combustible gases without mixing with them, thus causing slow combustion. The rate of mixing determines the rapidity of combustion of the combustible gases. With a perfect mixture and the usual furnace temperature, the velocity of combustion is very great indeed, so that the combustion is almost of the nature of an explosion.

From Technical Paper 137, U.S. Department of the Interior.



The constitution of industrial enterprise is largely departmental—"Spokes in a Wheel." This series has for its object the featuring of, in racy, interesting and instructive fashion, the training, experience and achievement of those who to-day are transmitting effectively, energy in a variety capacity as "Spokes in the Wheels" of steam, electrical and hydraulic and refrigeration engineering.

WILLIAM A. SWEET

THE development and transmission of electrical power has advanced to such a point, and demands such qualifications in the individual that it may well be said that wires like guns need men behind them. Electrical engineering in its operative features, requires a degree of practical experience equalled only by mechanical engineering, and obtainable only by lapse of time and occurrence of trouble. Just as it is impossible to cross bridges before you come to them, so is it impossible to gauge one's ability to overcome trouble until unwelcome events have presented themselves for solution. While it is not implied that the subject of these remarks has a special leaning toward trouble, it is believed that, because of the closeness with which his personal career and activity are interwoven with the development of his present duties, his biographical details possess more than passing interest for readers of this journal.

The early days of electrical engineering were characterized by a rapidity of development experienced by few other industries and the fact that our "Spoke's" experience with electrical machinery dates from the early "Eighties" is sufficient evidence that he not only knows how to meet trouble when it comes but what is perhaps more important, is capable of maintaining a preventive attitude against the trials and sorrows of the station engineer.

Born in the county of Wentworth, township of Salt Fleet, May 3, 1862, William A. Sweet is a Canadian son of Canadian parents, although four generations back his forefathers were of Holland birth. After receiving the ordinary school education of that period, he commenced work at the age of sixteen, learning the milling trade in the town of Woodburn, Ont., where he was employed at the Woodburn Flour Mills. They were owned by John Edmonds and during the three and a half years he was there, Mr. Sweet had charge of a beam engine having a cylinder 20 in. dia. by 5 ft. stroke, running at 30 revs. per min. An interesting feature of this plant was the presence of a water tube boiler of which the following description is given: A main horizontal shell about 6 ft. dia., and proportionate length, had a central rectangular flue 48 in. wide by 30 in. high. About 500 tubes were disposed vertically in this flue, connecting the water

W. A. SWEET.

spaces above and below the square flue. This boiler was made by some firm in Hamilton, whose name history recordeth not.

After a short time with Morgan Bros., who owned a flour mill in Hamilton, Mr. Sweet decided to become a real out and out engineer, and with this end in view he commenced his apprenticeship in 1882 with the firm of Reid & Barr, who were engaged in the building of stationary and portable engines and also boilers. The four years spent there were full of opportunity, particularly as regards the operation of machinery, a fact which was to be of considerable influence in the later activities of our friend.

At this time, Mr. Sweet devoted considerable time to study, taking both the electrical and steam engineering courses of the Scranton School, so that he was amply qualified to take charge of the electrical plant at the Royal Distillery, Hamilton. This equipment included one bi-polar dynamo of 400 light capacity, 2 bi-polar motors and one electric lift. Three boilers of 125 horse-power were installed, and the engines were one 100 horse-power, and one 20 horse-power, the latter being an Armington & Simms, built by the Inglis Co., of Toronto. The electrical machinery was built by Tom Kay, of Hamilton.

Mr. Sweet's connection with the various plants now owned by the Dominion Power & Transmission Co., dates from June 1, 1894, when he took charge of the power plant of the Hamilton, Grimsby and Beamsville Electric Railway, this plant being under his care till the present time. His duties were extended in Sept., 1896, to include the power plant of the Hamilton Radial Electric Railway, this latter plant being in continuous operation as a generating plant until 1901, when it was converted to a transformer and motor-generator station. At this time Mr. Sweet was placed in charge of all stations owned by the Hamilton Cataract Power, Light and Traction Co., these consisting of the old electric light plant on King street, the Street Railway plant at the foot of John street, and the Grimsby Electric plant.

The formation of the Dominion Power and Transmission Co., solidified the various electric projects in the Hamilton district and incidentally increased Mr. Sweet's responsibilities so that in addition to the companies mentioned he has charge of plants belonging to Hamilton & Dundas Street Railway, Dundas Electric Co., Brantford & Hamilton Elec. Ry., Hamilton Terminal Co., and Western Counties Electric Co. The Victoria Ave. sub-station belonging to the old Cataract Co., is the only plant where steam generation is still in use.

Social and political activities of limited degree have characterized Mr. Sweet's past life. Radical in politics and Anglican in religion, he has never been attracted by municipal politics. A Mason and member of the I.O.O.F., he is also a member of the C.A.S.E., being one of the old members of No. 2 Lodge, past president of the C.A.S.E. executive, and a warm friend of that organization.

Hunting is his chief relaxation, and a fall trip has been an annual feature for the last 25 years.

On Jan. 26, 1889, he married Cozens Tryphena, of Hamilton, the union being

blessed with two sons and two daughters, one of each of whom is married; the family residence being 78 Colborne St., Hamilton, Ont.

Outside of his duties, Mr. Sweet has various interests, one of special interest at this time being the Hamilton Molybdenum Alloys Co., of which he is a director. His success in life he attributes to a lot of mighty hard work, not a little of it being study in the wee sma' hours of the morning; in fact, he admits that his wife has occasionally hidden books from him for days at a time. She cannot, however, deprive him of technical papers, which appear regularly, and Mr. Sweet regards these as one of the necessities of life for the modern aspirant to success.

Cool collectedness is particularly necessary for successful electric station operation and both Mr. Sweet's personality and the various plants under his control bear out the truth of this assertion.

BRUSHES FOR SLIP RINGS

THE copper leaf brush for slip rings. which has been in favor since the days of incipient machines, is fast giving way to "block" or "metal graphite" brushes. Generally speaking, metal graphite brushes consist of various mixings of pulverized copper and other metals with graphite, shaped under pressure. When metal graphite brushes were first introduced their carrying capacities were greatly over-estimated. Manufacturers of electrical apparatus dropped into the error of using too few brushes, and in many instances found it necessary to increase the slip ring brush equipment as much as 50 per cent. before satisfactory results could be obtained in the field. At the present time the maximum permissible current is considerably below 150 amperes per square inch, while the safe limit is perhaps under 125 amperes per square inch. This type of brush is also used on direct-current machines of very low voltages. Its metallic characteristics, however, are at times hard on the commutators.

As a rule, the more highly graphitized brushes have proven the more satisfactory in that they have a longer life and cut the rings less. It is contended that these brushes are self-lubricating, and to a degree this is true. However, if the rings on which they run are kept free from copper dust, and a slight amount of lubrication (light oil) is judiciously applied, the life of both brushes and rings will in most cases be prolonged. This type of brush is extremely heavy and requires a brushholder of decided stability, with springs capable of pressures as high as five or more pounds per square inch. The actual pressure to be used is determined by the type of ring, speed of ring, and composition of the brush. It is, however, rarely less than three and one-half pounds per square inch, and more frequently five. When brushes of this type are allowed to spark they disintegrate rapidly and the life is greatly shortened.

In case the brush is not sufficiently granular in texture it will "roll up" or "fringe" or form "wire edges" on the sides. Obviously, such brushes are dangerous, for the reason that such edges frequently break away from the brush in full contact length, bridge to, or fall across, rings having different polarities, and flash the machine. To guard against this the brush should be slotted radially with a file, two slots to a side "V" shaped, and about one-eighth of an inch in depth. Under this condition the maximum possible length of thrown-off metal will be something less than one-third of the arc of the brush contact. This is too short to bridge or cause damage. Although a brush may be in every other way satisfactory, if it has this "fringing" characteristic it is not desirable.

Application of Slip Ring Brushes

All types of slip ring brushes should be installed so as to cover the full width of the ring, but never so as to permit the brush to overhang the ring. This is easily accomplished by properly "staggering" the brushes, all slip ring brushholders being designed for this adjustment. Metal graphite or "block" brushes are generally installed radially, and with either one or two brushes in each holder. When two brushes occupy the same holder they should be placed side by side —not in "tandem." If in "tandem," the leading brush is packed against the leading face of the holder by the lagging brush, due to the rotation resultant, and the brushes do not wear uniformly. It may be possible to overcome this by changing the brush angle, or by a change in the resultants of spring pressures. As previously stated, the pressure should be from three to five pounds per square inch.

A Rope Drive Puzzle.—In connection with rope driving the question is sometimes asked: "Why do some ropes revolve in the groove, while others do not?" In a paper on "Rope Driving," read recently by R. Edward Hart before the members of the Bradford Engineering Society, the author says this question has never been satisfactorily answered. It is reassuring, however, to learn from the paper that whether ropes revolve or not has very little to do with their longevity, as it is easy to point to both types which have worked well for many years. Some people, says the author, imagine that when a rope begins to revolve it is rapidly rubbing itself away; this is quite an erroneous view of things. As a matter of experience, the ropes which have the longest life are, in the majority of cases, quite circular in section. And when the ropes have been running for any length of time, it is always easier to tighten a round rope which has been worn evenly all over its surface than to attempt to resplice a rope which has worn V-shaped and taken all the wear on its two sides only. Some engineers prefer ropes to revolve, because they affirm that there is less frictional loss whilst leaving the groove with a round rope than with a V-shaped rope, maintaining that it partakes more of the nature of rolling friction.

ORDERING COMMUTATOR BRUSHES UNLESS the style, type, size and shunt equipment of a brush can be definitely given when brushes are ordered, the folfollowing information should be furnished the brushmaker, or the manufacturer of the machine, when an order for brushes is placed:—

1—Size of brush, in the following order:—Length, width, thickness.

2—Bare or copper-coated.

3—Brush angle; also if corners are square or chamfered.

4—State whether rotation is against toe or heel of brush.

5—If to be drilled for shunts, or countersunk, or both, give full particulars.

6—If to be equipped with brush-lifting devices, give full particulars.

7—State whether for one, two or more shunts, giving length of flexibles and styles of flexible terminals.

8—Specify if shunts or brush-lifting devices, or both, are to be either attached or supplied.

9—Give all information on the nameplate of the machine.

10—Give diameter of commutator (or rings).

11—State whether or not mica is undercut.

12—Give maximum number of bars touched by the brushes.

13—Give number of segments between centre of positive and centre of negative brushes.

14—Give number of poles (or brush arms) and number of brushes per arm.

15—State if machine is of commutating-pole or non-commutating-pole type.

16—Give style or type of holder.

17—If brushes in use have not proven satisfactory, state in what respect they have failed.

18—If convenient, forward a used sample of the brushes in service. It frequently happens that a more suitable brush can be prescribed and that an examination of the original brush will not only suggest a substitute having superior characteristics, but at the same time eliminate possible errors in brush dimensions, shunt applications and brush-lifting mountings.

19—Bear in mind that brushholders differ greatly in detail and that the application of shunts for either direct or alternating-current service must be specified; otherwise the shunts might interfere with the pressure springs and a set of brushes be rendered useless.

20—It is also well to furnish a sketch of the brush.

21—If for "try-out" purposes, state what service the machine is doing; hours of service; minimum, average and maximum loads, with duration of each; also if machine is subjected to gas or acid fumes, and what, if any, troubles have been experienced.

From the above it must be concluded that if what is wanted is expected it must be made clear what is wanted. Even then it may not be available. Brush requirements are in no sense stable. It is wise, therefore, to encourage a receptive disposition and to be ready for such advances in the art as may seem worth while.—Electric Journal.

Sub-Station Equipped With Auxiliary Steam Plant

Staff Article

The merits of a steam plant—elasticity, emergency availability and generally speaking, all-round reliability, insure a continuance of such equipment, principally as reserve power in many electric systems. DeCew Falls, illustrated herewith, possess the unique feature of having been the original inspiration of the now important electric system which covers such an important part of the Niagara Peninsula.

DECEW FALLS.

NOTWITHSTANDING the high degree of perfection attained in the development of hydro-electric systems, the necessity of a steam plant, either as an auxiliary or reserve, or both, is recognized to a considerable degree by many operators who control public service plants, and the Victoria Avenue substation of the Dominion Power & Transmission Co., Hamilton, Ont., is an interesting example of equipment, which, while primarily designed for auxiliary purposes, possesses a sufficient overload capacity to enable it to act as reserve to quite a considerable degree in the case of sudden emergency.

The sub-station itself possesses considerable interest in that it was erected by the old Hamilton Cataract Power, Light & Traction Co., which was subsequently absorbed by the Dominion Power & Transmission Co., which now controls and operates numerous subsidiary companies in the Hamilton district.

VIEW OF OFFICES AND MAIN ENTRANCE, VICTORIA AVENUE SUB-STATION.

Main Power Station

The hydraulic power plant is located near DeCew Falls, a short distance from St. Catharines, and 34 miles distant from Hamilton. The effective head obtained is 265 ft., almost the entire difference in level between Lake Erie and Lake Ontario, and the highest head of any of the power plants in the Niagara peninsula. When first erected in 1897, the plant consisted of one penstock and two hydraulic units with an output of 3,000 units. To-day there are seven penstocks, each 750 ft. long by 6 ft. dia., supplying power to electrical units of about 7,000 horse-power each, and giving a total output for the plant of 52,000 horse-power.

DECEW FALLS POWER PLANT OF THE DOMINION POWER AND TRANSMISSION CO.

The gate-house, penstocks, and power house are illustrated in one of the accompanying engravings, as is also DeCew Falls, which give their name to the locality, and suggested the title of the old Cataract Co.

Main Line Transmission

There are three separate main lines, which transmit the power from the Falls to Hamilton at 44,000 volts, terminating at the switching station at the eastern extremity of the city, this station being entirely out of doors and the first of its kind in America. From the switching station three lines enter the city of Hamilton, two run to Brantford, a distance

of 23 miles, and one runs to the Beach, Burlington, and Oakville, a distance of 22 miles. The various districts are provided with sub-stations for transforming the voltage to suit local requirements and two of these stations—Victoria Ave. and Cannon St., have motor-generator sets installed which supply direct current to the Hamilton Street Railway Co. The transformer capacity of the Cannon St. sub-station is 8,000 k.w., while the sub-station at Irondale, East Hamilton, has a transformer capacity of 7,000 k.w., no motor-generators being installed here.

Plant at Victoria Avenue

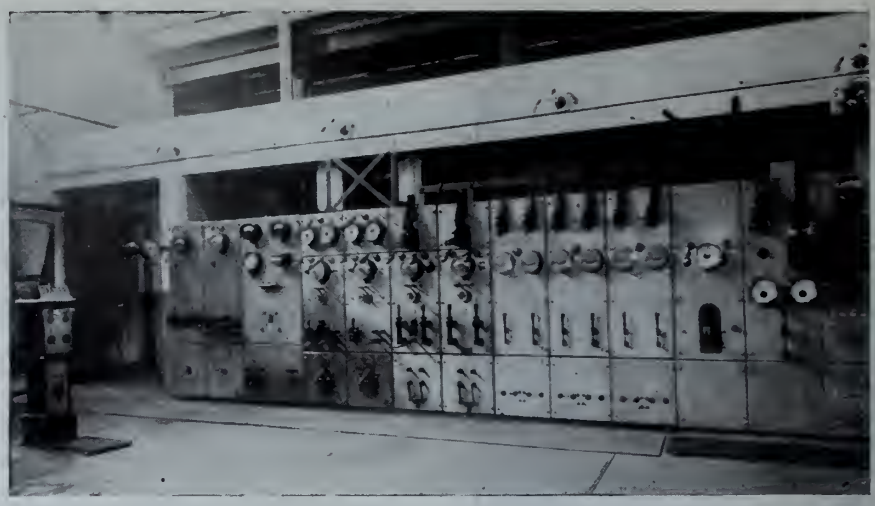
The Victoria Ave. sub-station which is illustrated in the accompanying engravings is of similar transformer capacity to the Cannon St. sub-station, but with the added capacity of the auxiliary steam plant which is the principal feature of the installation.

BATTERY OF OIL SWITCHES BETWEEN LIGHTNING ARRESTERS AND TRANSFORMER ROOM.

The transmission line from the switching station enters at the south or rear side of the building (see illustration), this being 3-phase, 2,400 volt, a.c. current. The lightning arresters are located outside in the open, from which the lines pass into the switch room. The interior of this room is shown in one illustration, the oil switches being installed in front of a brick wall which forms one end of the transformer room.

Transformer Room

The transformer room occupies most of the west side of the building and contains 16, 500-k.w. units arranged in two banks of 8 each. Situation between the banks is a brick wall of cellular construction, extending up to the roof. As shown in illustration of transformer room, the wall is divided into three square conduits or passage by means of concrete slab divisions which both insulate and protect the three-phase conductors coming from the switch room. The transformers are of Canadian Westinghouse make and deliver two-phase current at 2,400 volts. The illustration shows clearly the arrangement of the transformer room and the connections from each unit to the three-phase conductors located in the conduits referred to.



SWITCHBOARD FOR STREET RAILWAY MOTOR GENERATORS. CONCRETE CONDUIT FOR MAINS OVERHEAD. MAINS RISE IN CONCRETE COLUMN BACK OF LATTICE WORK.

Motor-Generator Department

The two-phase current from the transformers is led by underground conductors to the motor-generator department, which occupies about one-third of the building from front to back. The switchboard equipment is arranged around two sides of this department, the west side being occupied almost entirely by the railway board in connection with the motor-generators, while the north side is occupied by the high tension lighting load board and local power panels.

The railway switchboard, a photograph of which is reproduced, consists of 13 gray marble panels, the extreme right hand panel carrying the return mains and also the sectional switches for the railway. Automatic switches in connection with the booster equipment occupy the adjacent panel, while the remaining panels are equipped with standard types of instruments and apparatus for controlling the supply of alternating current to, and delivery of direct current from the two motor-generator sets.

These sets are installed exclusively for supplying 600 volt direct current to the street railway and are of identical size and type. They are of Canadian Westinghouse manufacture and consist of a 1,330 horse-power synchronous motor, operating with the two-phase, 2,400 volt current at a speed of 333 revs. per min., and direct-connected to a direct current generator of 750 k.w. capacity delivering 1,250 amperes of current to the railway switchboard at an E.M.F. of 600 volts. The armature shaft extends

END VIEW OF TRANSFORMER ROOM SHOWING CELLULAR CONSTRUCTION OF CONDUIT WALL.

out from the generator and embraces the exciter unit which is mounted at the end of the bed plate. This unit is of 50 k.w. capacity, delivering 400 amperes at an E.M.F. of 125 volts.

Booster Equipment

The booster set for the motor-generators consists of a 170 horse-power Canadian Westinghouse constant speed induction motor operating with two-phase, 2,400 volt current at a full load speed of 645 revs. per min., direct-connected to a 112½ K.W.d.c. generator having an output of 1,500 amperes at 75 volts. The remainder of the apparatus in the motor-generator department includes an independent motor driven exciting set of 50 K.W. capacity, consisting of a Bliss non-condensing steam turbine operating at 160 lbs. per sq. in. and a Diehl generator delivering 125 volt current, speed of set being 2,000 revs. per min.

Reference was made to the switchboard on the north side of the building, and this can be seen in the view of the motor generator department. The mains from the transformers rise through a vertical concrete column to the top of the railway switchboard from whence a conduit extends horizontally around the two sides of the department directly above the switchboard. The switchboard referred to is of comparatively simple construction of 18 panels arranged for individual lighting and power loads for various concerns in the vicinity. These operate on the two-phase, 2,400 volt current direct from the transformers, and are divided equally between lighting and power. A 15 ton overhead traveling crane built by Pawling and Harnischfieger, provides lifting capacity in any part of the motor-generator room.

Steam-Generator Department

The auxiliary steam plant is of more than passing interest to Canadian power house operators, being excellent examples of modern high class engine design and possessing special operating features which, while remarkable enough at the time of their installation in 1903, are still little if any surpassed by similar units as built to-day. These sets are the subject of one of the illustrations, while they can also be observed in the background of the view of motor-generator room.

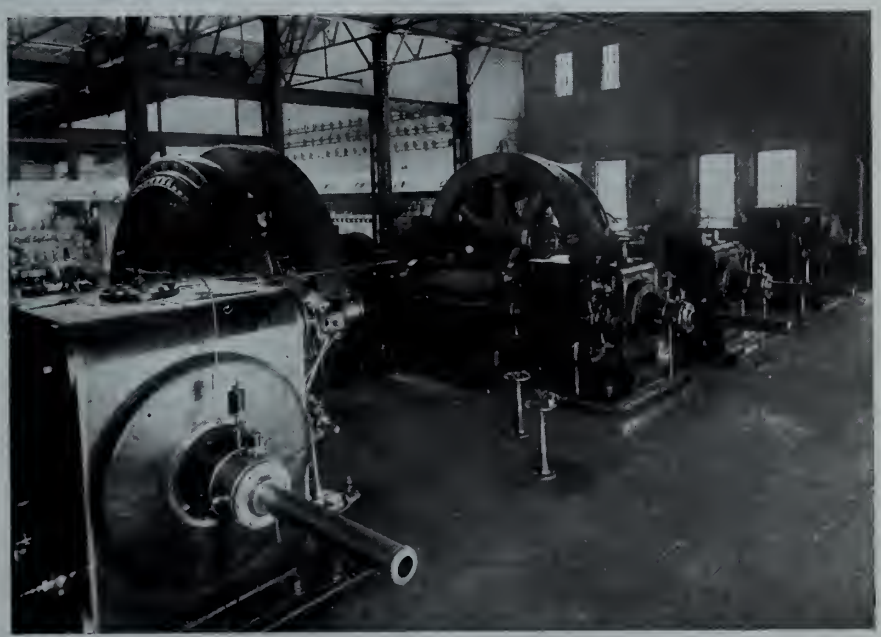
The generators are of the Westinghouse engine type and are of 1,000 k.w. capacity, delivering two-phase, 2,400 volt current, with 8,000 alternations when running at 100 revs. per min. The engines were designed and constructed by the Goldie & McCulloch Co., of Galt, Ont., and are of the cross compound non-condensing type. An initial steam pressure of 150 lbs. per sq. in., is employed, which, at 30 per cent. cut off in the high pressure cylinder, will develop 1,500 horse-power, while a maximum overload of 50 per cent. can be carried allowing an output of 2,250 horse-power per engine.

MOTOR GENERATOR DEPARTMENT. BOOSTER EQUIPMENT IN RIGHT FOREGROUND WITH SYNCHRONIZING SWITCHBOARD FOR STEAM GENERATORS BEHIND.

Special interest attaches to these units because of the high frequency of the generators and the fact that they are run in parallel with each other and also with the water-driven alternators at the main power plant at DeCew Falls, thirty-four miles distant. This is largely possible through the use of "Rites" inertia governor with which these engines are equipped, the regulation obtained by means of this device being within remarkably close limits. A variation in speed, from no load to full load, of less than one per cent. can easily be obtained, but in practice it has been found advisable to increase the variation to about one and one-half per cent. because of the fact that the response of the engines to sudden changes in load was so much more rapid than the other source of power with which they were running in parallel, that the engines were constantly overloaded while awaiting increased output from the remainder of the plant. For this reason, therefore, the sensitiveness of the engine governors was reduced so as to allow more sympathetic behaviour between the steam plant and the hydro-electric plant.

Engine Details

The high pressure cylinder is 28 in. and the low pressure 52 in. dia., giving a cylinder ratio of 3.5 to 1. Each cylinder has a stroke of 46 in., which at 100 revs. per min., gives a piston speed of 768 ft.



TWO GOLDIE & McCULLOCH CROSS-COMPOUND TRIP-VALVE ENGINES DRIVING 1000 K.W. WESTINGHOUSE GENERATORS.

per min. The valve gear is operated by a horizontal revolving shaft with four eccentrics, one to each valve. The valves are of the flat grid-iron type, seated on removable plugs which are ground into the cylinders, thus allowing the valves and seats to be scraped to a true surface before assembling in the cylinder, and also permitting of easy and rapid removal in case of wear.

As will be gathered from the illustration, the valves move across the cylinder, the trip gear on the inlet valves being controlled from the governor by a small shaft parallel with the eccentric shaft. The dash pots are carried on the outer end of the trip gear bracket and are used for cushioning only, the actual closing of the valve being done by the unbalanced steam pressure on the valve spindle. The rapidity of closing obtained by this arrangement is such that the valve gear can be run at rotative speeds up to 150 revs. per min.

REAR VIEW OF VICTORIA AVENUE SUB-STATION SHOWING TRANSMISSION LINES AND LIGHTNING ARRESTERS. BOILER HOUSE IS AT EXTREME RIGHT.

The exhaust valves are worked by a combination of links which gives a very rapid opening and closing of the valve, and a dwell during the time they are opened or closed. The use of multi-ported valves with large surfaces reduces wear to a minimum, and the placing of the valve faces horizontally insures perfect lubrication. The maximum cut-off obtainable on the inlet valves is seventy-five per cent. of the stroke.

Between the cylinders below the floor level is a reheating receiver fitted with drawn brass tubes, and a by-pass is also provided for admitting live steam to the low pressure cylinder. The tail rod bearings are adjustable in all directions so that the piston may be accurately adjusted in the cylinder.

The cross head is of the circular bearing type with babbitted shoes which are adjustable and removable, the piston rod being screwed into the cross head and secured by a heavy nut. Connecting rods of the solid end type are used, the cross head box being bronze and the crank end brass lined with babbit.

The crank shaft is made of open hearth forged steel, solid, and weighs 28,000 lbs., its diameter at the bearings is 22 in., and at flywheel and generator 24 in. Counterbalanced crank discs of semi-steel are fitted, the crank pin being ground to a taper fit, shrunk in and secured by a thin steel nut at the back.

Fly Wheel Construction

The 60 ton flywheels are of the built-up type, 18 ft. in dia., the rim being in eight sections, which are held together by wrought iron links on the two outer and also on the inner side. Each section has one arm cast integral, the inner ends of the arms being held between the hub flanges. The hub itself is in the form of two discs, the whole being held together by reamed bolts which pass through the hub and the inner end of the arms.

The engine frame is of the heavy duty type with internal ribbing. It is cast in one piece and supported for its full length on the foundation. The bearings are 22 in. dia. by 38 in. long, and are babbitted. They are of the four part type with side wedge adjustment; the outside of the shells is turned to fit the bored frame thus permitting of an easy removal of the bottom shell by rotating around the shaft. The total weight of each engine is 300,000 lbs.

The steam-generator switchboard is situated on the east side of the motor-generator department (see illustration thereof), and consists of two panels equipped with Westinghouse instruments and apparatus. The control of the engines is operated from the switchboard, a small motor being arranged on the governor gear whereby the attendant can alter the tension of a supplementary spring and thus synchronize the generators.

The office entrance and main frontage of the building is on Victoria Ave. (see illustration), and the boiler house is at the opposite corner from the office. The firing floor is about twelve feet below street level, and hand-fired Stirling boilers are installed, the use of mechanical stokers not being justified by reason of the intermittent nature of the load. To facilitate rapid pick-up under load, induced draft is employed, two steam driven Buffalo fans exhausting into a 72 in. stack, 85 ft. in height. Automatic draft control is obtained by means of a Mason regulator which operates two 4 ft. dampers, one for each bank of boilers.

As can be observed from the views reproduced, the entire plant is in excellent condition considering the number of years it has been in operation. In 1902, when the present superintendent, W. A. Sweet, took charge, there were 10 transformers of 200 k.w. each; now there are 16 transformers of 500 k.w. each. The motor-generators at that time were three in number, of 300 k.w. each, while today these are replaced by two motor-generators of 750 k.w. each, in addition to which the steam auxiliary plant was installed in 1903.

The technical activities of the Dominion Power & Transmission Co. are directed by W. G. Angus, general superintendent and electrical engineer, while the entire sub-station equipment, in Hamilton, Oakville and Brantford, is under the personal supervision of W. A. Sweet, sub-station superintendent, to whom we are indebted for much of the information and data contained herein.

HORSE POWER OF BELTING

USERS of belting are frequently misled as to the amount of work which should be got from a good belt.

The power of belting is determined by the number of foot pounds which can be transmitted by one pulley to another, and is arrived at by multiplying the effective pull in pounds per inch of width by belt width in inches and by belt speed in feet per minute; thereafter dividing by 33,000.

The effective pull or the force tending to turn the pulley is the difference in tension between the slack and driving sides of the belt and is largely dependent on the arc of contact between the belt and the smaller pulley. To find the effective pull it is necessary to determine the number of degrees in the arc of contaoct. This can be arrived at by mutiplying the difference between the pulley diameters in inches by four and three-quarters, dividing the product by the distance between the pulley centres in feet, and subtracting the quotient from 180 degrees.

The allowable working strain for a single belt with 180 degrees contact is, 40 pounds per inch width. This multiplied by the arc of contact found in the previous calculation and divided by 180 will give the effective pull allowable in pounds.

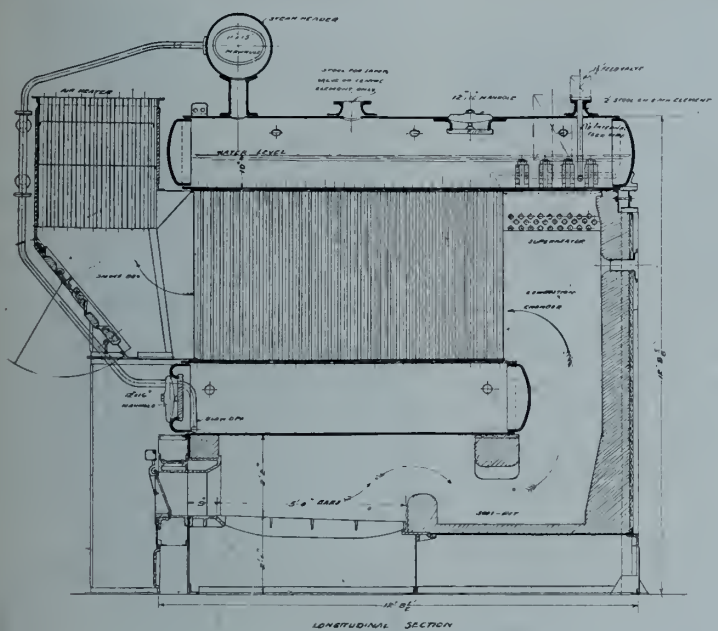
The "Howden" Sectional Type, Water-Tube Steam Boiler

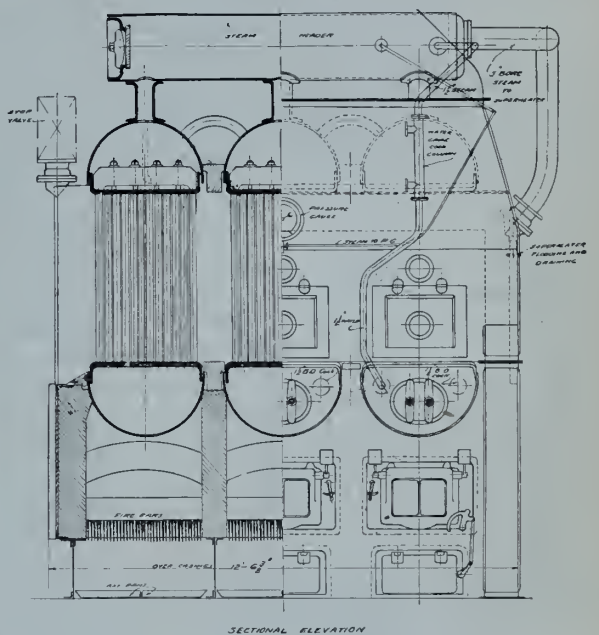
By C. T. D.

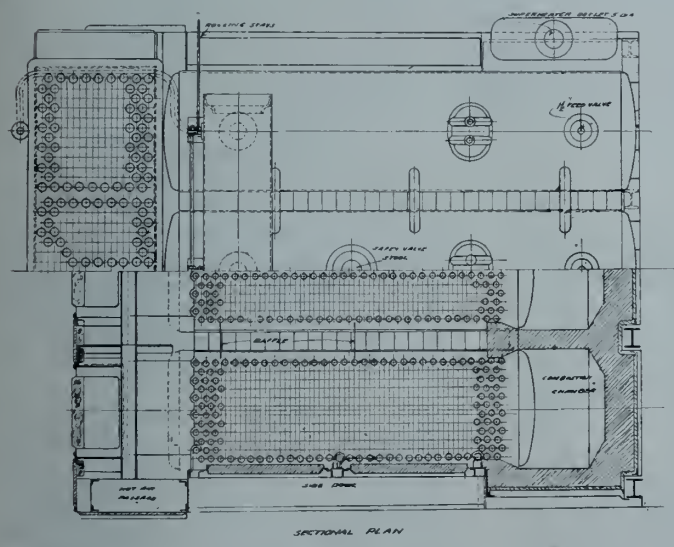
With the development of an intensive shipbuilding and marine engineering activity, there has resulted both a tendency and necessity to deviate from the beaten path in the matter of design and constructional detail of a number of the prime essentials entering into one or other, or both of the twin industries. The accompanying article features a type of water-tube boiler now being made in Canada, suitable for either land or marine installation, but which has hitherto figured but little, if any, as a factor in her steam engineering practice.

THE "Howden" boiler as we find it to-day is a development of one designed in January 1861 by the late James Howden, of "forced draught" fame, and who in his lifetime was chairman of both James Howden & Co., marine machinery builders, and of the Howden Boiler Co., Govan, Scotland. As the date when the first Howden boiler was constructed occurred at a stage of marine engineering during which the use of high pressure steam for marine purposes took a sudden leap upwards, anticipating a progress which was not generally reached until fully 20 years thereafter, it will doubtless be interesting after an interval of some 56 years to chronicle the circumstances which initiated and led up to the present design.

In 1861, the usual steam pressures for marine boilers were from 20 to 25 pounds per sq. inch, beyond which it was not considered safe to operate with a salt water feed supply. Shortly before this period, however, several attempts had been made to introduce steam pressures of 100 pounds per sq. inch into steamships with compound surface condensing engines. Among these pioneers of the use of high pressure steam through compound engines and the use of fresh feed water, was the chairman of the Howden Boiler Co., who in 1859 contracted with the "Anchor Line" Steamship Co., to equip one of their Mediterranean fruit steamers with his then recently patented compound surface condensing engines and boilers to work with steam at 100 pounds per sq. inch. This steamer built by Alexr. Stephen & Sons, on the upper reaches of the Clyde, began to run in 1860, being successful and economical, running voyage after voyage without requiring overhaul or repair. Her boiler was as far as known, the first high pressure steam generator to operate successfully at sea in ordinary traffic continuously for a considerable period.







HEATING SURFACE	BRITISH	DUTCH
BOILER	2800 ft	2500 ft
SUPERHEATER	117 ft	30 ft

WORKING PRESSURE 180 LBS PER SQ INCH

GRATE AREA 45.8 ft

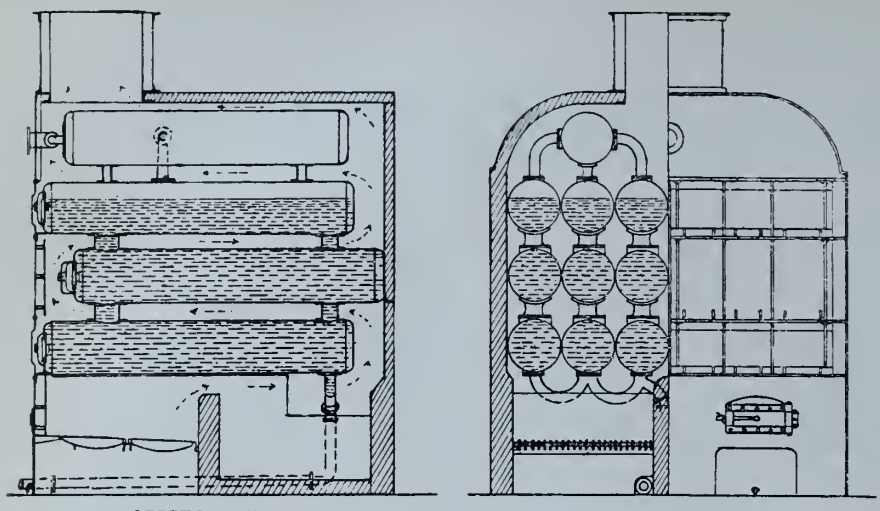
TO THE REQUIREMENTS OF THE BUREAU VERITAS REGISTER OF SHIPPING

SCALE 3/4" = 1 Foot.

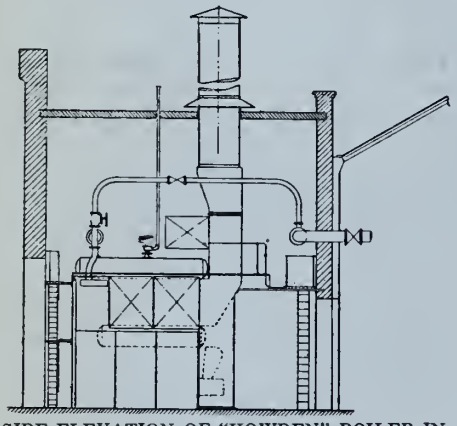
THREE ELEMENT "HOWDEN" MARINE TYPE WATER TUBE BOILER NOW BEING MADE IN CANADA.

Another screw steamer ordered about

the same time by J. H. P. Hutchison for their trade between Glasgow and Bordeaux, and built by James R. Napier, F. R. S., at Govan, had compound surface condensing engines, also boilers using 100 pounds per sq. inch steam pressure, installed. Owing to the then design of the boiler, however, and the effect of salt water from a leaky surface condenser, this vessel never accomplished a voyage to Bordeaux and back without being laid up on account of the boiler requiring overhaul and repair. Inaccessibility for cleaning and repair were drawbacks to the boilers and, with a view to giving greater convenience in these respects, a new design was developed and gave satisfactory operating results, notwithstanding the fact that leaky surface condensers were responsible for abnormal incrustation of salt on the interior boiler surfaces. The accessibility procured limited materially the heating surface, hence rapid combustion, which progress in steamship engineering necessarily entailed, was more or less negatived. The subsequent evolution of the cylindrical multitubular boiler (Scotch), with its simpler style, and greater heating surface in same space occupied, evidenced a more economical design, and being, in addition, better fitted for the marine service of that period, naturally took pride of place, and still maintains a strangle hold.

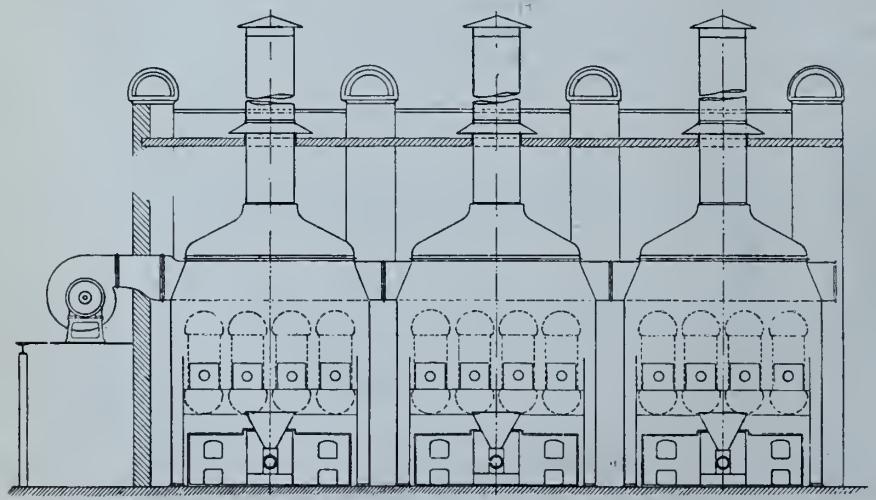


ORIGINAL DESIGN OF "HOWDEN" BOILER, JANUARY, 1861

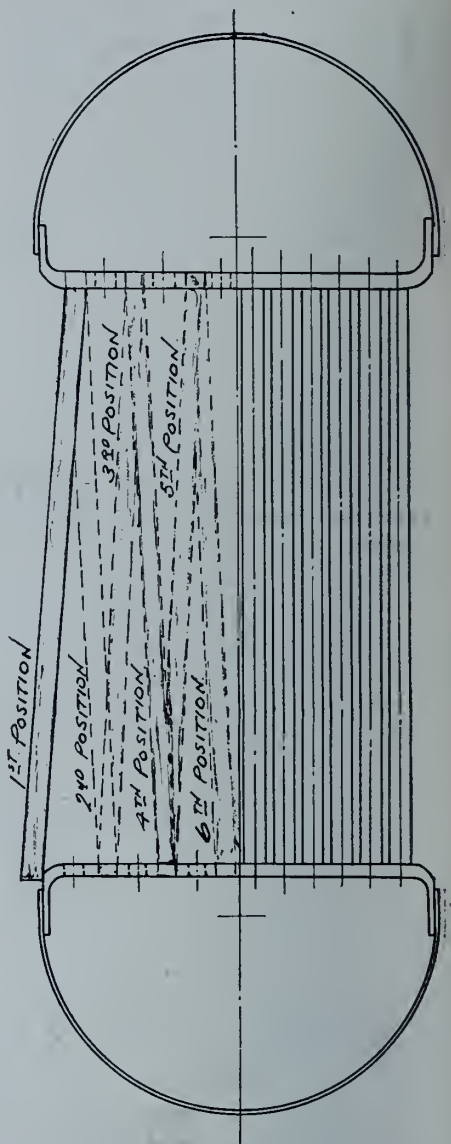


SIDE ELEVATION OF "HOWDEN" BOILER INSTALLATION AT BOROUGH OF BERMONDSEY ELECTRIC LIGHT STATION

The present Howden boiler combines an evaporation from plate surfaces, as in ordinary boilers, with the addition of that from water tubes. It is now constructed under at least three patents—1908, 1910 and 1912, respectively, the last mentioned including a design specially adapted for high speed steam vessels, where lightness and small space occupied are of vital importance, or, for use on land in places difficult of access where the several parts can be carried by men or animals and put together without skilled labor under the direction of one competent engineer. All Howden boilers are designed to be equally suitable for land or marine services. As will be noted from the illustrations, covering boilers now being built by the Polson Iron Works, Toronto, who are the licensees for Canada, the individual units are simple in character, there being the minimum of detail parts, while the sections or elements are duplicates of each other. One boiler may consist of one, two, three, four, or more elements, all the details of which lend themselves to repetition and duplicate work, therefore all parts can be made by special machinery to standard gauges, ensuring accuracy of duplication and good workmanship. The Howden boiler is adapted to work safely and economically under the highest air pres-



FRONT ELEVATION OF "HOWDEN" BOILER INSTALLATION AT BOROUGH OF BERMONDSEY ELECTRIC LIGHT STATION

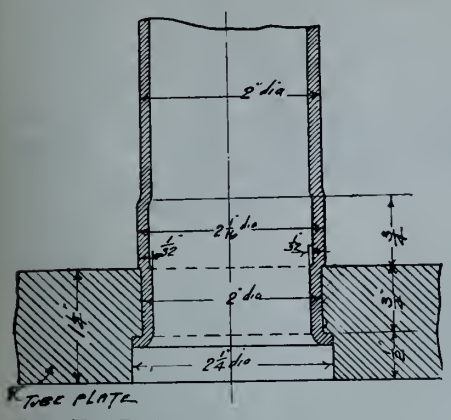


METHOD OF STEPPING-IN NEW TUBES

The worst possible position for a leaky tube is indicated. The intervening tubes are of course cut out and the new one threaded into position as shown. In consequence the holes are slightly larger in diameter than they were originally after expanding. This slackness allows the tubes to to be stepped into the various positions. The inner tubes require renewing at rare intervals.

sure of the Howden system of forced draught, and at the highest steam pressures now employed.

All parts of the boiler when working are under an equal heat, that is, no one

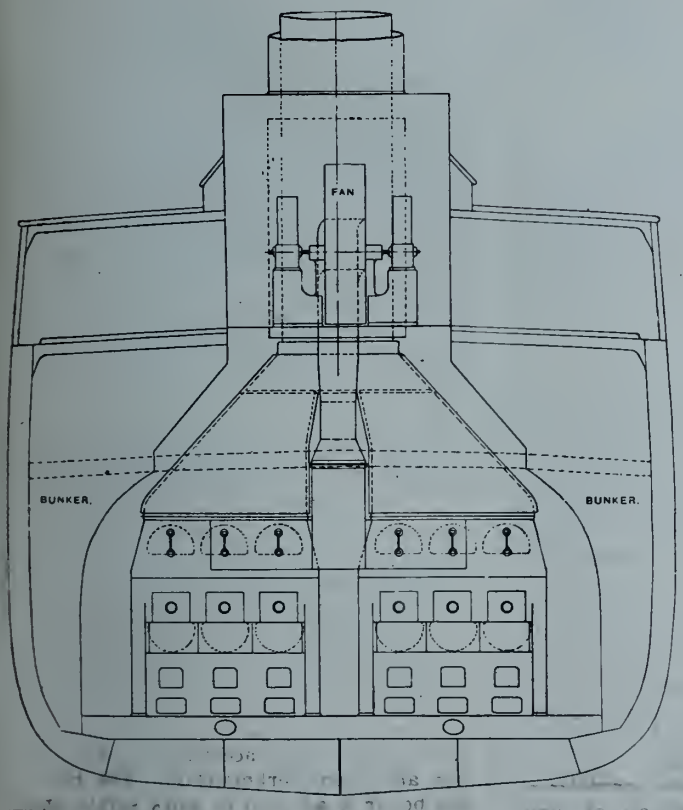


DETAIL OF TUBE FASTENING IN TUBE PLATES

Tubes cutter and extractor should be used for withdrawing tubes when possible, but if hand chisel be used, great care must be taken so as not to injure tube plates.

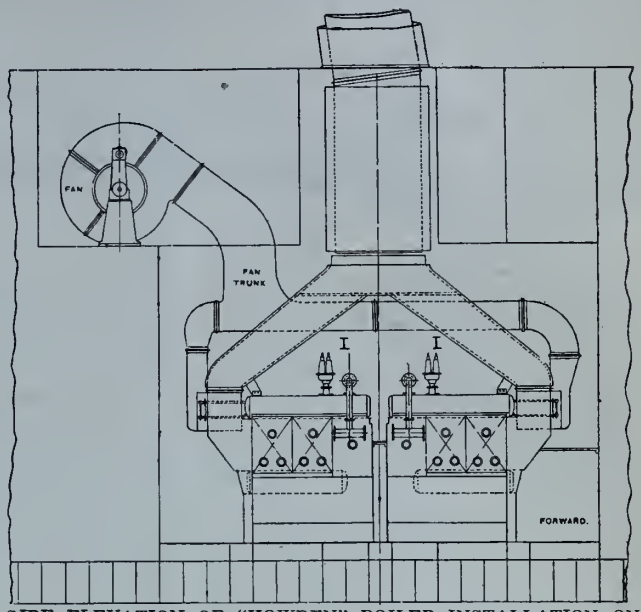
place is hotter or colder than another, while, in raising steam from cold water, all parts are brought under heat at the same time. The design lends itself to a rapid positive natural circulation without piping or other adjuncts, also to internal self-cleansing in the water tubes and drums where the water is in continual rapid movement over the surfaces exposed to the hot fire gases. In the matter of accessibility, attention is called to the fact that in a four element boiler, by the removal of eight manhole doors, the whole of the internal working parts of the boiler, that is, top and bottom drums and tubes, are at once open for examination when necessary. The fact that the tubes are short and straight is a matter of much importance, as they can all be examined in each element in a few minutes. For outside examination, the side portable doors can be quickly opened or removed, also the smokebox doors; and further, the combustion chambers are accessible by manholes from their underside, from which the back and tubes can be examined. Tubes can be removed and replaced quickly, the method of doing so being illustrated, as also the scheme of their fixing in the drum tubeplates.

In the fitting of Howden boilers into steamships, important savings are effected. Vessels which are to have cylindrical boilers installed cannot be finished completely at the yard in which they are built, as marked spaces in decks and upper works above the boiler rooms must be kept open, not only for purpose of lowering heavy cylindrical units into place by crane after launching, but the work must be finished in such a way after the boilers are on board that these decks and upper works may be opened up again to remove the boilers when they are worn out or damaged, which always takes place after a longer or shorter period of service, and in order to refit the vessel with new boilers. In large high power steamships, the cost of opening up and reclosing deck work, etc., together with that for crane service, amounts to a large sum. In the case of the Howden boiler, the several parts can be put on board by either the shipyard derricks or those of the vessel herself, being afterwards lowered to place for erection, through the stokehold hatchways or the funnel opening.



FRONT ELEVATION OF "HOWDEN" BOILER INSTALLATION ON BOARD SHIP.

The Howden boilmay be equipped with chain grates or other mechanical stokers for land installations and may be operated under either forced or natural draft, although necessarily only with the former can the highest economy and power be obtained. The boiler patents include a superheater of simple and efficient design integral with the structure of each generating unit, also



SIDE ELEVATION OF "HOWDEN" BOILER INSTALLATION ON BOARD SHIP.

a feed heater or water back forming part of the boiler evaporative surface, which is specially suitable for naval installations where reduction of weight and increase of tube surface and power in a given space are of material importance. When superheated steam is not required, the superheater can be immediately converted into ordinary heating surface, and thereby increase further the evaporative capacity of the boiler. From the illustrations accompanying, no difficulty will be experienced in grasping the detail features which go to make up either individual or combination units.

Test of No. 1 "Howden" Boiler

Heating Surface	3,125 sq. ft.
Grate Area	54 sq. ft.
Duration of Test	6 hours
Coal Burned (Bituminous Scotch)	11,058 lbs.
Coal Burned per Hour (average)	1,803 lbs.
Coal Burned per sq. ft. Grate	34.1 lbs.
Total Ash and Clinker	1,120 lbs.
Ratio of Ash and Clinker to Coal Fired	10 %
Total Water Evaporated	107,100 lbs.
Water Evaporated per Hour (average)	17,850 lbs.
Water Evaporated per lb. of Coal as fired under 192 lbs. pressure	9.68 lbs.
Water Evaporated per lb. of Coal as fired from and at 212 degs. Fah.	11.38 lbs.
Water Evaporated per lb. of Combustible at 192 lbs. pressure above atmosphere	10.7 lbs.
Water Evaporated per lb. of Combustible from and at 212 degs. Fah.	12.58 lbs.

Steam Pressure ...192 lbs. per sq. in.
Feed Temperature entering Boiler (Water Heated with Live Steam from Boiler).. 97 degs. Fah.
Temperature of Water in Feed Tanks ..... 59 degs. Fah.
Funnel Gas Temperature .....473 degs. Fah.
Temperature of Gases Entering Air Heater 545 degs. Fah.
Temperature of Air in Reservoir .....196 degs. Fah.
Atmospheric Temperature at Fan ..... 72 degr. Fah.
Air Pressure at Fan ....2⅝ inches
Air Pressure in Ashpit ....1¼ inches
Air Pressure in Furnaces .... ½ inch
Moisture in Steam (by Barrus Calorimeter.....About 1%
Flue Gas Analysis, $C.O_2$ ....14.8 %
Flue Gas Analysis, C.O. ..... Nil.
Flue Gas Analysis O. 4%
Funnel 3 ft.-8 in. in diameter, 34 ft. in height above uptake, and 50 ft. above fire grate.

Steam was disposed of during the trial by blowing off into the atmosphere. Ashes were cleaned from ashpit forty minutes preceding the start of the test, and all observable clinker removed at that time. The fires burned freely, very little smoke being observed, and that only when firing.

Three Element Boiler Detail

The illustrations on the first page of this article show the three element Howden boiler, several of which are being constructed at the Polson Iron Works Toronto, for wooden freighters being built in various yards in Canada. Although the principal features have already been summarised, a few particulars regarding the general construction will be of interest. The boiler is made up of three elements having a total heating surface of 2800 sq. ft., while the superheater has 117 sq. ft. of heating surface. The grate area for .75 in. forced draught is 45.8 sq. ft., the fire bars being 5 ft. long. The evaporation per hour from feed at 120 degs. Fah., is 13750 lbs., thus the boiler as shown in the illustration referred to above, will give a total evaporation of 1350 lbs. per hour from combined heat absorbing surface of 2800 sq. ft. and 45.8 sq. ft., .75 in. forced draught grate area, with coal of not less than 12,000 b.t.u. per lb.

The boiler is supported in steel framework in such a manner as to allow free expansion. The units are encased with brick and have doors at the side for getting at the tubes for cleaning or renewing. The feed and blow off enter the lower drum at the front head into an arrangement of internal pipes. Provision is made in combustion chamber and smoke box door for removing soot from the tubes belonging to the boiler and air heater. The forced draught is of "Howden" latest and improved type, as are also the fire doors which, when opened, automatically shut off the draught. The space occupied by the boiler including brickwork is as follows:—Width, 12 ft. 6⅜ in.; depth 12 ft. 8 ins.; and height 12 ft. 9 ins.

COMBUSTION IN FUEL BED OF HAND-FIRED FURNACES

THE rate of feeding air through the fuel affects directly the rate of combustion; that is, if the weight of air forced through the fuel bed in a given time is doubled, the rate of combustion of the fuel is doubled; if the weight of air is tripled, the rate of combustion is also tripled, and so on. In other words, the weight of air forced through the fuel bed per pound of fuel burned or gasified is constant. By increasing the rate of feeding air, only the rate of combustion is increased and not the weight of air used per pound of combustible. It is, therefore, impossible to regulate the excess of air in any hand-fired furnace by increasing or decreasing its flow through a level fuel bed.

Air Over Fuel Bed Necessary

As the gases rising from the fuel bed contain a high percentage of combustible and no free oxygen, and as the amount of air per pound of fuel can not be increased by increasing the rate of supply through the fuel bed, it is apparent that to obtain complete combustion some air must be added over the fuel bed. Thus the percentage of CO_2 in the gases in any hand-fired furnace can be controlled only by regulating the supply of air admitted over the fuel bed. This fact and the one stated in last paragraph, namely, that by increasing the rate of feeding air through the fuel bed only the rate of combustion is increased, are important in the operation of hand-fired and some other types of furnace. It is well to state in this connection that forced-draft apparatus can not supply enough air through a level fuel bed to insure complete combustion. Additional air must always be introduced over the fire in such a manner that it will mixe with the combustible gases, otherwise a large percentage of them escapes unburned.

Many a careful fireman has noticed that he makes less smoke and burns less coal if he keeps the dampers in the firing door open than when he keeps them shut tight. Frequently leaving the fire doors partly open is found helpful in reducing the smoke to a great extent and results in saving coal. In some installations special openings are provided either in the front of the furnace or through the bridge wall for the introduction of air over or beyond the fuel bed. Partly open firing doors, or special openings in the furnace, supply additional air, which burns the combustible gases rising from the fuel bed. The admission of air can be regulated to suit the rate of combustion, and at the same time maintain efficient burning of coal.

With a level fuel bed and an absolutely tight furnace, perfect combustion would be impossible even when burning anthracite coal or coke. However, such conditions are seldom or never found in practice. The firing may be done so poorly that there are thin spots or holes in the fuel bed a large part of the time. Through these holes air may enter the furnace in sufficient volume not only to make complete combustion possible, but often to raise the supply of air far beyond the most economical quantity, and cause excessive chimney losses. The fire doors never fit tight, neither are the brick furnace walls free from leaks, so that in some cases the leakage around the furnace doors and through the brickwork is far more than enough for complete combustion. Thus careless firing and a neglected boiler furnace and setting may cause the addition of air over the fuel bed to appear unnecessary.

Holes in Fire and Leaks in Furnace Undesirable

From what has been said in the last paragraph it might seem that careless firing resulting in holes in the fire, or a leaky furnace and setting, were desirable features, as they introduce additional air over the fuel bed, and thus to some extent aid complete combustion. However, holes in the fire and leaks in the furnace are most undesirable methods of introducing air into furnaces and deserve condemnation, as the amount of air introduced into the furnace can not be regulated to suit the requirements.

The holes in the fire are small immediately after the firing and grow larger as the coal burns out. Thus, when large volumes of volatile combustible are rising from the fuel bed immediately after firing and when a large amount of air is needed, the quantity of air admitted is small. As the coal burns out and the holes become larger, more air is admitted into the furnace. At the same time the volume of combustible gases rising from the fuel bed become smaller; first, because the greater part of the volatile matter has already been driven off, and, second, because holes in the fire reduce the pressure drop from the ash pit to the furnace, thereby decreasing the flow of air through the covered part of the grate, with the result that less fuel is gasified than with no holes in the fire. Therefore, less air is needed to burn this smaller volume of combustible gases, so that the quantity of air flowing into the furnace through the holes in the fire is far in excess of the amount actually needed for complete combustion. Thus when air is intraduced through holes in the fuel bed there is incomplete combustion owing to insufficient air at one time and too large an excess of air shortly afterwards.

The leakage of air into the furnace increases as the draft becomes higher, and the draft in the furnace increases as the clinker accumulates on the grate, or as the fuel bed through any cause becomes thicker. Clinker on the grate and thick fires also reduce the flow of air through the fuel bed, thereby reducing the rate of combustion or gasification of the fuel on the grate. Thus with clinker on the grate or thick fires there is a large amount of air leaking into the furnace when a small volume of combustible gases is being generated, and not enough air when the fuel bed is clean and thin and a large volume of combustible gas is being generated.

Power Transmission Section

SAFETY STANDARDS FOR POWER TRANSMISSION MACHINERY

THE specifications describe standard guards for all power-transmission equipment hereinafter mentioned, and apply to all main shafting, jack shafting, drive shafting and countershafting, and their belts and other attachments up to but not including belts actually driving machines.

Class A Guards—If the clearance between the guard and the guarded part is less than five inches, a metal guarding material that will not admit objects larger than one-half inch in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Class B Guards—If the clearance between the guard and the guarded part is five inches or more, a metal guarding material that will not admit objects larger than two inches in diameter, strong enough to withstand loads to which it may be subjected, durable enough to withstand ordinary wear and tear, substantially fabricated and erected, and free from sharp points and edges.

Handrails—If the clearance between the guard and the guarded part is fifteen inches or more (measured horizontally from extreme parts within six feet of floor), a handrail forty-two inches in height with at least one intermediate rail, supported at least every eight feet, substantially fabricated and erected, with no sharp points or edges.

If constructed of pipe, the rails and posts shall be at least equal in strength to 1¼ inch standard-weight pipe.

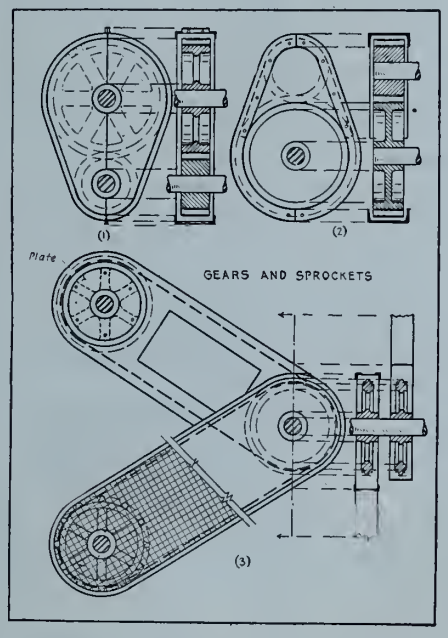
If constructed of structural metal, the rails and posts shall be at least equal in strength to 2x2x¼-inch angles.

If constructed of wood, the top rail shall be 2x4 inches, and the posts 4x4 inches, all straight-grained lumber dressed on four sides, or other construction of equal strength.

Toe Boards—When power-transmission equipment extends through floors or into pits, Class A and B guards shall extend to the floors, or toe boards six inches in height shall be provided around the floor opening in addition to standard handrails. (See Figs. 6, 7, 11, 14, 30, 31, 34, 48.)

Sanitary Bases—Class A and B guards, for power-transmission equipment not extending through floors, shall enclose exposed sides to two inches below the bottom of the lowest moving part when the clearance between that part and the floor is less than eight inches; or when the clearance between the lowest moving part and the floor is eight inches or more, the guards shall be closed on the bottom, or extended on all sides down to six inches above the floor. (See Figs. 15, 26, 36-40, 42, 43, 49.54.)

Gears and Sprockets—All power-driven gears and sprockets shall be completely enclosed on exposed sides with standard guards as specified in Class A or B, except in cases where the design and operation of the parts to be guarded



FIGS. 1 TO 3. GUARDS FOR GEARS AND SPROCKETS.

make a complete enclosure clearly impractical, in which case the face of the gears or sprockets shall be covered with a band guard surrounding all exposed teeth, with flanges on both sides extending inward beyond the roots of the teeth, and there shall be a continuous smooth web cast or fitted between the hubs and rims of the gears or sprockets. (See Figs. 1, 2, 3.)

Vertical and Inclined Belts, Ropes, Chains—All vertical and inclined belts, ropes and chains used for transmitting or distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident), shall be provided with standard guards as specified in Class A or B, six feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 4 to 46, inclusive.)

Horizontal Belts, Ropes, Chains—All horizontal belts, ropes and chains used for transmitting or distributing power (except belts traveling less than 120 feet per minute, or transmitting so little power that accidental contact therewith could cause no accident), shall be guarded as follows:

Low Belts—If the upper part of the belt is lower than six feet above the floor or working platform, it shall be provided with standard guards specified in Class A or B, six feet high on exposed sides, or on exposed sides and top, or with a standard handrail on exposed sides. (See Figs. 47-50.)

Medium Belts—If the upper part of the belt is higher than six feet above the floor or working platform and the lower part of the belt is lower than six feet above the floor or working platform, it shall be provided with standard guards as specified in Class A or B, six feet high on exposed sides, or with a standard handrail on exposed sides. (See Figs. 51-58.)

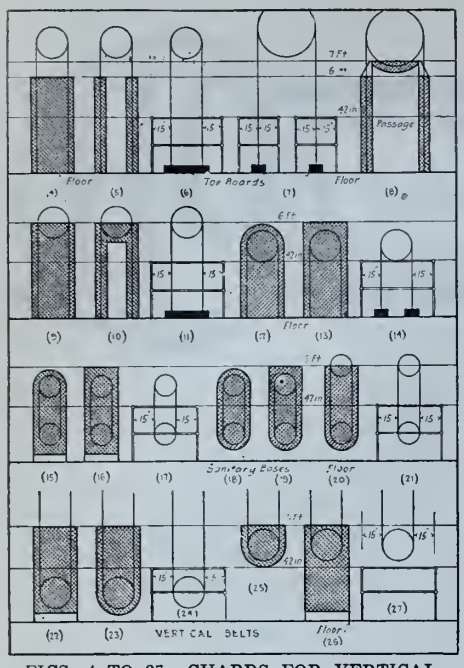
High Belts—If the lower part of the belt is higher than six feet above the floor or working platform and lower than seven feet above the floor, it shall be provided with standard guards as specified in Class A or B, on exposed sides and bottom, or with standard handrail on exposed sides. (See Figs. 59, 60.)

Belts over Driveways—Where a horizontal belt is located over a driveway or passageway, the highest floor of any wagon or truck passing beneath the belt shall be considered a working platform.

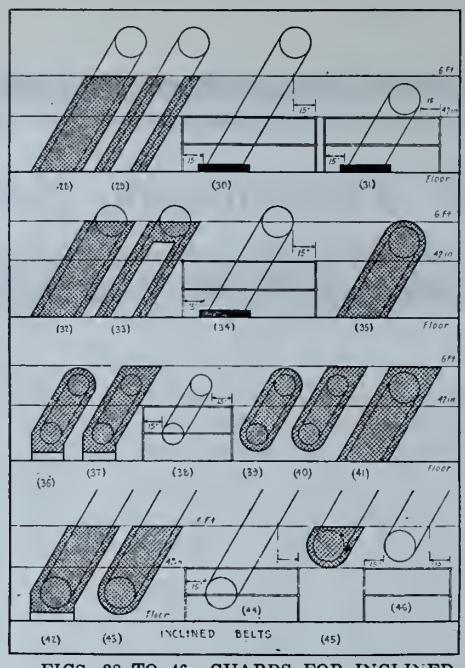
Belt Fasteners—All belts not provided with guards as specified in Class A or B and within seven feet of the floor or working platform shall be free from metal lacings and metal fasteners.

Belt Shifters—Belt shifters shall be provided for all tight- and loose-pulley belts, and shall be so designed and constructed that ordinary vibrations or accidental contact will not alter the set position, and shall have a controlling handle conveniently located. (See Figs. 61-63.)

Pulleys—Pulleys belted from above or from the side in such a way as to allow passage beneath the pulley, and within seven feet of the floor or working platform and not completely enclosed by standard belt guards or handrails, shall be guarded to the top of the pulley or to a height of seven feet above the floor or working platform on exposed sides and



FIGS. 4 TO 27. GUARDS FOR VERTICAL BELTS.



FIGS. 28 TO 46. GUARDS FOR INCLINED BELTS.

beneath by guards as specified in Class A or B, or be enclosed on exposed sides by standard handrails. (See Figs. 64-67.)

Bearing Clearance.—The clearance on shafting between pulleys and bearings or between pulleys and fixed objects shall be not less than thirty-six inches and wider than the belt, or the pulleys shall be guarded on the near side with stationary guards as specified in Class A or B, and all revolving objects in the clearance shall be smooth, cylindrical and concentric with shafting. (See Figs. 68-73.)

Belt Clearance—The clearance on shafting between pulleys and pulleys, collars, couplings or other revolving attachments shall be wider than the widest belt used, or the pulleys shall have flanges or guards to prevent the belt from dropping into the clearance. (See Figs. 68-73.)

Abandoned Pulleys—Pulleys without belts shall be guarded as though belted, or removed from revolving shafts.

Clutches—Friction clutches, jaw clutches and compression clutches within seven feet of the floor or working platform or within thirty-six inches of a bearing shall have their operating mechanism completely enclosed in stationary guards as specified in Class A or B, or in smooth, concentric revolving guards of solid construction with no projecting parts or attachments.

Couplings—All couplings within seven feet of the floor or working platform or within thirty-six inches of a bearing shall be guarded as follows:

Rigid Couplings—Sleeve couplings and flange couplings shall be cylindrical and concentric with the shafting and with no parts or attachments projecting beyond the largest periphery of the coupling or its projecting flanges. (See Figs. 74, 75.)

Flexible Couplings—Flexible and universal couplings shall be completely enclosed in standard stationary guards as specified in Class A or B, or in smooth concentric revolving guards of solid construction.

Clamp Couplings—Clamp couplings and makeshift devices of irregular shape or unknown strength are prohibited on power-driven shafting.

Collars—Assembled collars shall be smooth, cylindrical and concentric with shafting, with no projecting parts or attachments. See Figs. 76, 77.)

Set Screws—All set screws in revolving parts not enclosed by standard guards as specified in Class A or B shall be flush with or countersunk below the periphery Figs. 76, 77.)

Keys—All keys or keyways in revolving shafting not enclosed by standard guards as specified in Class A or B shall be made flush with the end and periphery of the shaft or enclosed by smooth, cylindrical concentric guards.

Vertical Shafting—Vertical shafting with or without collars, couplings, clutches, pulleys, or other attachments shall be enclosed on exposed sides with standard guards as specified in Class A or B to a height of six feet above the floor or working platform, or with a standard handrail. (See Figs. 78, 79.)

Horizontal Shafting—Horizontal shafting with or without collars, couplings, clutches, pulleys, or other attachments, including dead ends, within seven feet of the floor or working platform, shall be enclosed on all exposed sides with standard guards as specified in Class A or B or with standard handrail, or with freely revolving tubing. (See Figs. 80-82.)

Shafting over Driveways—Where horizontal shafting is located over driveways or passageways, the highest floor of a wagon or truck passing beneath the shafting shall be considered a working platform.

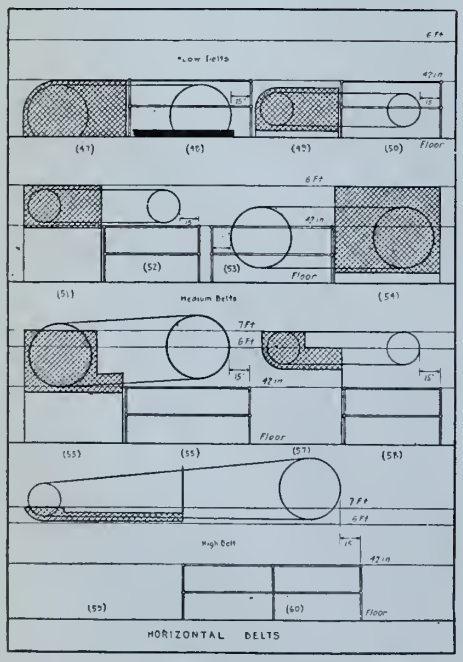
Emergency Stop Stations—A station or stations shall be provided in each room, section, or department to stop immediately all power-transmission equipment therein. Such station or stations shall be properly marked and easily accessible and provided with means for locking in "stop" position.

Bearings—Where possible, bearings shall be of a self-oiling type with reservoir capacities for at least 24 hours' running or shall have other methods of oiling which do not bring the oiler in the danger zone, and shall have necessary drip cups and pans securely fastened in position.

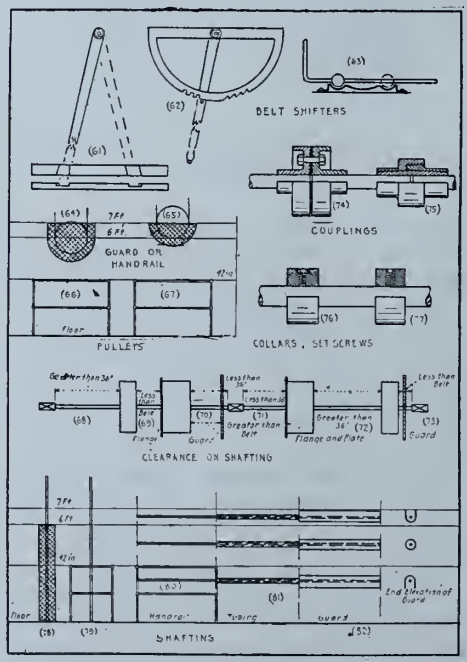
Lubrication—Oiling which brings the oiler in a danger zone shall be done only by an authorized person, and while the machinery is not in motion.

Oiler's Clothes—The oiler must not wear loose or flowing clothing.

Oiler's Lock—The oiler shall be provided with a lock and key or with a key to the locks at the emergency stop stations, and with a warning sign to display at the stations when at work on ma-



FIGS. 47 TO 60. GUARDS FOR HORIZONTAL BELTS.



FIGS. 61 TO 82. GUARDS FOR MISCELLANEOUS EQUIPMENT.

chinery controlled by that station. He shall be required to lock the station in a "stop" position and display the sign before going to work, and unlock and remove the sign when the work is completed and all men have left dangerous places.

Starting Signals—Ample notice should be given by means of an effective alarm or signal in all departments before power-transmission equipment is started.

Inspection — All power-transmission equipment should be carefully inspected at frequent and regular intervals by foremen or authorized inspectors, and defective equipment should be reported for repair and records kept of inspections.

Repairs and Adjustments—Repairs and adjustments to power-transmission equipment or guards therefor shall be made only when the power is cut off from that equipment, and guards shall be replaced in protective before the power is cut on.

Removing Guards—Guards installed in accordance with this Code shall not be removed or rendered ineffective.

The foregoing constitutes the tentative draft of a Code of Safety Standards for Power-Transmission Machinery compiled by Carl M. Hansen and Rufus W. Hicks under the direction and with the consent of the Committee on Health and Safety, National Association of Manufacturers, and presented at this year's spring meeting of the American Society of Mechanical Engineers. An author's note states that the use of properly designed, constructed, and installed individual motor-driven equipment with electrical power distribution not only eliminates many of the hazards demanding this Code, but also gives an uninterrupted distribution of natural and artificial light, and a greater flexibility and range of speeds than is possible with mechanical power distributing systems.

HANDY CHART FOR BOILER SHELL COMPUTATIONS

By W. B.

THE accompanying chart will be found useful for determining three different things:

1.—It will give the shell thickness of the boiler, knowing the pressure in pounds per sq. in., and knowing the diameter of the boiler in inches.

2—It will give the pressure in pounds per square inch when the other two factors mentioned in (1) are known.

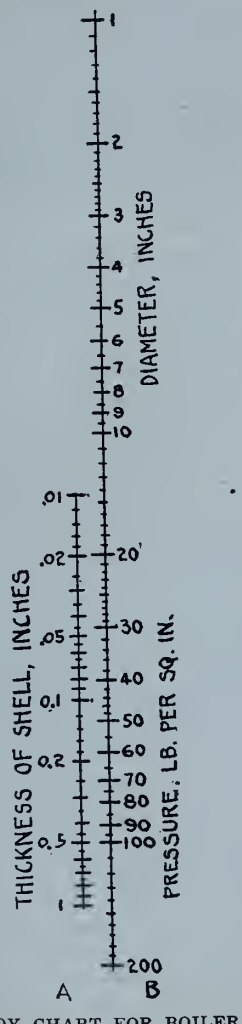
3—It will give the diameter of the boiler in inches when the other two factors also mentioned in (1) are known.

For example, given a boiler made of mild steel, whose internal diameter is 34 inches, and whose shell thickness is .25 inch. What pressure may be safely held within the shell? ?

Find the 34 in column B and measure the distance down to .25 in column A. Then from the .25 measure downward that self-same distance, and the answer will be immediately found in column B as 150 pounds per square inch. This chart is based on 10,000 pounds per square inch as the safe stress to which the metal can be subjected, therefore the answer is the safe working pressure to which the shell can be subjected.

In case it is desired to find the thickness of shell, knowing the other two factors, all that is necessary is to locate the two known points in column B and then find the mid-point. The answer is to be found directly opposite that mid-point in column A.

To find the diameter to which a boiler can be safely made, knowing the shell thickness, and knowing the pressure, the operation is practically the same as in the first example cited. This will be better understood when it is pointed out that the shell thickness would have to be



HANDY CHART FOR BOILER SHELL COMPUTATIONS.

the same for a pressure of 34 pounds and a diameter of 150 or for a pressure of 150 pounds and diameter of 34 inches. Do you get the point? That is why the chart is reversible.

The range of the chart is wide enough to cover nearly every common boiler condition. Its highest pressure is 200 pounds per square inch and the highest shell thickness is one inch.

In case the metal is steel, this chart is especially applicable, allowing a factor of safety of nearly six. In other words, where the breaking strength of the metal is 60,000 pounds per square inch, this chart automatically includes the factor of safety of six. If the metal is cast iron, or something weaker, the chart will not hold without allowance being made.

BEARING LUBRICATION

A STUDY of the influence of surface velocity on the mean film thickness in the lubrication of bearing forms the subject of the paper which received the student prize of the American Society of Mechanical Engineers in 1917. The paper was prepared by Boynton M. Green, of Leland Stanford, Jr., University.

The apparatus used in the experiments on which the paper was based is shown in Fig. 1. It is non-adjustable and consists of a plain phosphor-bronze sleeve about 3¼ in. in diameter and 7 in. long, pressed into a cast-iron housing which was bolted to a lathe bed. Lubrication was effected by two steel oil rings of rectangular section. Two sets of oil grooves were cut in the upper half of the bronze as shown in the sketch. On assembling the bronze sleeve and housing it was found that the bronze was elliptical in section, the major axle being vertical. The average difference in diameters was 0.001 in.

While for best results the sleeve should have been reamed after pressing it into the housing, the inaccuracy did not seem to affect the results appreciably. The journal was a piece of mild steel ground to a diameter of 3.244 in., giving a running fit allowance of 0.0035 in., or about 0.001 in. per inch of diameter. On each end of the journal a 67-lb. cast-iron flywheel was secured by a nut. The total weight of the assembled journal, flywheels and nuts was 165.5 lb., making a nominal load on the bearing of 7.275 lb. per sq. in. of projected area. The entire apparatus was mounted on two parallel lathe beds, and three lathe heads with four-step pulleys were utilized for the drive. To locate the position of the journal relative to the bearing, three micrometers were used, spaced 120 deg. apart around the bearing in a plane through its centre and perpendicular to its axis.

In determining the mean thickness of oil films, the following approximations were made:—(a)—The loaded portion of the film was that below the horizontal plane through the centre of the bearing. (b)—The thickness of the film at this plane and on each side of the journal was equal to the radial bearing allowance. (c)—The mean thickness of film was the average of the thickness at this plane and the minimum thickness of the film. The minimum thickness of the film is the radial allowance minus the distance between axes of the journal and bearing.

The curve plotted from the results gave the general equation:

$$y = b + c^a \sqrt{V}$$

in which y = means thickness of film in inches.

b = one half the radial allowance.

c = constant, dependent on allowance and possibly on viscosity.

a = constant, dependent on viscosity and possibly on allowance.

V = surface velocity of journal in feet per minute.

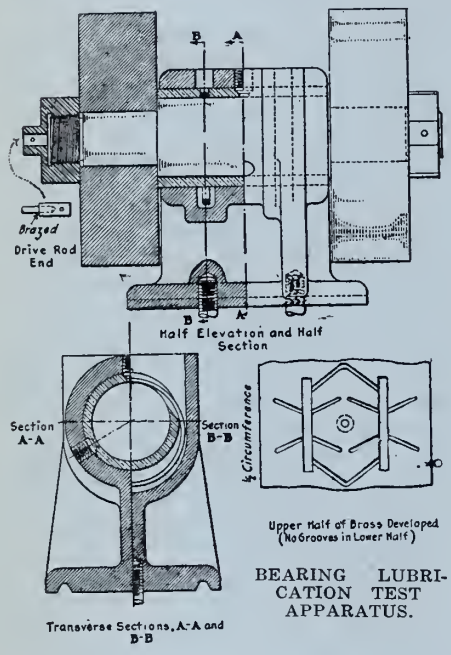
From the experimental figures the values of c and a were found to be: c =

0.0000049; a = 1.8, and the resulting empirical equation is

$$y = 0.0000049^{1.8} \sqrt{V}$$

As to the application of the empirical equation in the general equation for bearing lubrication, it may be said that it can be used directly for conditions of the same allowance and the lubricants having the same viscosity. For other allowances and lubricants the change of (c) and (a) cannot be stated definitely. In general (c) will change with some function of the allowance and (a) with some function of the viscosity.

The oil used during the experiment was an ordinary mineral oil known as "vacoline," manufactured by the Standard Oil Company. Its viscosity was given by the Engler viscosimeter as 11.0 at 20 deg. C. and 2.95 at 50 deg. C., compared with water at 20 deg. C., which gave a specific viscosity of 38.9 at 20 deg. C. and 8.7 at 50 deg. C.—"



BEARING LUBRICATION TEST APPARATUS.

POWER TRANSMISSION BY CHAIN

ALTHOUGH the question of power transmission is only one of many to which the engineer has to give his attention, yet in these days of great and increasing activity, it comes about that none of us can afford to be indifferent to any factor which makes for better, quicker or cheaper production. Plants, factories and mills are extending in every direction as the supply falls short of the demand, and it is the engineer with the knowledge of where to save, who is mainly responsible for these extensions. That chain driving, which has many advantages over other methods of power transmission in many cases is a factor of considerable importance, is evidenced by the fact that in every part of the world engineers are using this drive to a large extent. Space does not permit us to discuss the design of chains and their many applications, opportunity will therefore only be taken to summarize a few of the advantages accruing from their service adoption.

The chain drive is positive, inasmuch as the chain cannot slip on the wheels. It is elastic, inasmuch as the weight of the chain which hangs between the wheels may act as a spring; the lubricant in the bearings, and in certain cases even the shape of the links adding to this quality. The effect of this elasticity is to considerably reduce the vibration and noise inseparable from such a positive power transmission as spur gearing, while the positive nature of the chain drive has in many cases increased the production of machines from 15 to 30 per cent.

Chain driving is highly efficient; experiments having shown that the efficiency of a well-designed chain drive is somewhere between 97-98½ per cent. Also, the nature of the action of the chain upon the wheels is such that this high efficiency is maintained throughout the life of the drive, and is not seriously affected by minute inaccuracies of erection, as in the case with some forms of tooth gearing.

As compared with rope or belt, the centre distance for chain driving never exceeds 8 feet or 9 feet and can, if circumstances require, be made so small that the chain wheels barely clear one another. For this reason it is even possible to take out a pair of spur wheels, replace them by chain wheels of smaller diameter and get, as the result, a highly satisfactory drive as regards efficiency and absence of noise and vibration.

Partly on account of the above advantages, and partly because it is not necessary that there should be any greater initial tension in the chain than such as is caused by its own weight, there are very heavy incidental economies, effected by chain driving. The absence of tension results both in saving of power and in reduction of wear and tear of bearings, shafting and machine parts.

Chain Drive Limitations

There are many locations and conditions particularly suited for belts, ropes and gears, and these systems will never be discarded; yet as the system of power transmission by chain has become more widely known, its advantages have been quickly appreciated and its popularity greatly increased among prominent Canadian firms. Chain driving, of course, has its limitations; for instance, where power has to be transmitted at right angles, or where the driving and driven shafts run in opposite directions. This latter instance in itself debars its use on fully half the machine tools in service, and where otherwise it would be applicable. Chains are not affected by moisture, heat or oil; belts and ropes tend to slip under such conditions, with resultant loss of power accompanied by destructive heat. It was, however, in cases where shafts were too far apart for gears, and too close for belts or ropes, that chains made their debut. Their success in these fields suggested trials in others.

Quiet Running and Compactness

In many instances, the gear makes no greater sound than a medium-sized belt. It is impossible to have metallic pieces moving with absolute silence, and its degree is affected by the speed of the chain and the number of teeth in the sprockets. Noise is only produced when the chain speed is excessive, and when the number of teeth becomes very low.

Compactness is probably one of the most important advantages chain transmission offers over belts or ropes, and it secures admission for the system into an unlimited field of application. The chain sprockets are approximately one-half the size of belt pulleys of the same capacity, and they may be placed quite close together, thus economizing in space, and often providing a more convenient and satisfactory arrangement of machines. Again, the width of the chain is usually about one-third the width of a belt for the same power.

First Cost

To many, the first cost of a chain drive is an obstruction; this being about 50 per cent. for small powers, and as low as 35 per cent. for large powers, higher than a belt drive of equal capacity. It should be borne in mind, however, that higher efficiency, saving in power and increased production, mean more satisfactory transmission at low cost. There are several hundred chain drives in use in Canada, a large majority of which are transmitting upwards of 200 h.p., with centres as short as six feet.

ROPE TRANSMISSION

THE main features of an ideal rope-drive are that the diameter of the pulleys shall not be less than thirty times the diameter of the rope used, and the driving and driven pulleys shall, if possible, be of equal diameter, but where this cannot be arranged, their ratios should not be greater than 5 to 1. The distance between the pulley faces should, if possible, be not less than 25 feet, and the drive should be horizontal, with the slack side of the rope on the top. The speed may be from 2,000 feet to 4,000 feet per minute, but if too low the ropes are apt to slip, and if too high, the action of centrifugal forces affects the efficiency.

There should be a distance of from 4 to 6 feet clearance under the ropes, and these must, of course, not rub on anything. An allowance of 2 or 3 inches clearance between the bearing foundations and the sides of the pulleys must be made so as to leave room for the ropes to be put on to the pulley. The pulleys must also be accurately in line, well balanced, and the grooves exactly alike.

All gears between the prime mover and the rope-drive should, if possible, be avoided; the ropes should be kept dry, properly lubricated, and not too tight. They should all be put on at one time, and the full load applied to them as soon as possible after they are in place. Carrier pulleys, rollers, and angular drives should be avoided as much as possible.

Rope driving is applicable and works satisfactorily in cases of indirect as well as direct requirement.

Practice of Oil Burning Under Stationary Steam Boilers*

By B. S. Nelson

The scarcity and high price of coal for steam raising, etc., has naturally directed attention to the subject of oil fuel as a substitute. In recent years much progress has taken place in the direction of high degree efficiency of equipment for oil burning, and many installations have been made in consequence. While there is little prospect of an oil scarcity devloping, there is nevertheless a tendency for its price to soar, a very material increase being noted in the period covered by the war to date. Advantages of oil over coal, aside from cost, are dealt with in the accompanying article, and are worthy of close study.

FUEL oil is oil which is more valuable to the producer as fuel than as a refined product. Due to the rapid increase in use of gasoline in motor vehicles and the use of distillates in stationary engines, and also to the improvements in refining crude oils, it is probable that very little crude oil will be used for fuel, and that the fuel most used will be some sort of residuum or scalped oils; that is, being distilled and the residue used as fuel. The result of this will be that more attention will have to be paid to the oil-burning system than was necessary with the lighter crude oils used heretofore, because a scalped oil is heavier and more viscous than crude oil. One advantage in using a scalped oil is that there is less fire risk, because its flash point is higher than the flash point of the crude oil.

The flash point of an oil is of interest particularly from the standpoint of safety. On land installations, where the oil is usually buried in a closed tank, the flash point is of less importance than on shipboard, where inflammable vapors are apt to accumulate in the hull or to be freed in a closed boiler room, due to leaky piping.

The viscosity of an oil is the principal

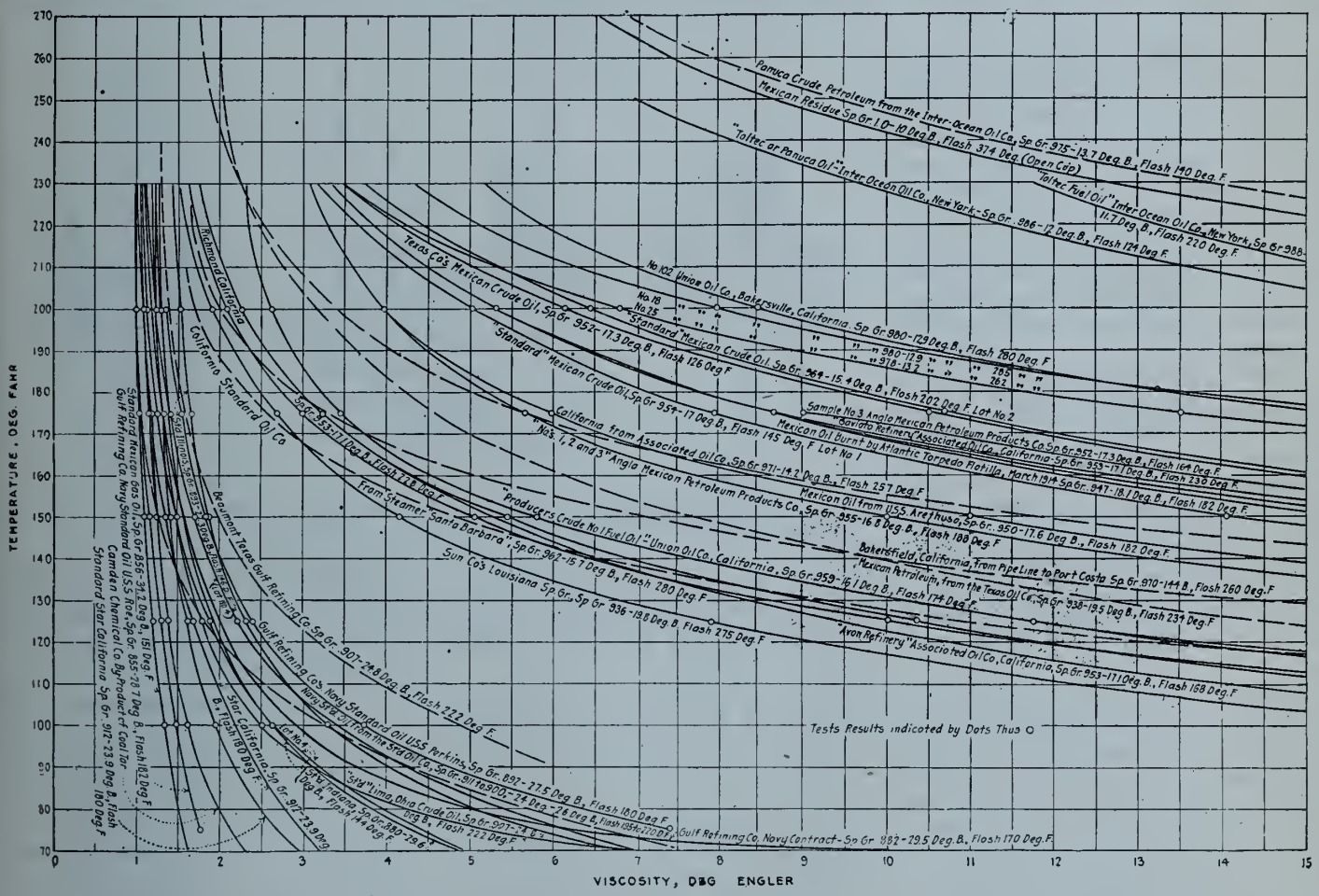

TEMPERATURE, DEG. FAHR
VISCOSITY, DEG ENGLER
Tests Results indicated by Dots Thus O
Pamuca Crude Petroleum from the Inter-Ocean Oil Co., Sp. Gr. 975-13.7 Deg. B., Flash 140 Deg. F.
Mexican Residue Sp. Gr. 1.0-10 Deg. B., Flash 374 Deg. (Open Cup)
"Toltec or Panuca Oil" Inter-Ocean Oil Co., New York-Sp. Gr. 986-12 Deg. B., Flash 124 Deg. F.
"Toltec Fuel Oil" Inter-Ocean Oil Co., New York, Sp. Gr. 988-11.7 Deg. B., Flash 220 Deg. F.
No. 102 Union Oil Co., Bakersville, California. Sp. Gr. 980-12.9 Deg. B., Flash 180 Deg. F.
No. 18 " " " " " 980-12.9 " " " 195 " "
No. 15 " " " " " 970-13.7 " " " 162 " "
"Standard" Mexican Crude Oil Sp. Gr. 968-15.4 Deg. B., Flash 207 Deg. F. Lot No. 2
Texas Co's Mexican Crude Oil, Sp. Gr. 952-17.3 Deg. B., Flash 126 Deg. F.
"Standard" Mexican Crude Oil, Sp. Gr. 957-17 Deg. B., Flash 145 Deg. F. Lot No. 1
Sample No. 3 Anglo Mexican Petroleum Products Co. Sp. Gr. 952-17.3 Deg. B., Flash 164 Deg. F.
"Bovina Refinery" Associated Oil Co., California-Sp. Gr. 953-17 Deg. B., Flash 230 Deg. F.
Mexican Oil burnt by Atlantic Torpedo Flotilla, March 1914 Sp. Gr. 941-18.1 Deg. B., Flash 182 Deg. F.
Mexican Oil from U.S.S. Arethuse, Sp. Gr. 950-17.6 Deg. B., Flash 187 Deg. F.
Nos. 1, 2 and 3 "Anglo Mexican Petroleum Products Co. Sp. Gr. 955-16.8 Deg. B., Flash 188 Deg. F.
Mexican Oil from U.S.S. Prometheus, Sp. Gr. 971-14.2 Deg. B., Flash 257 Deg. F.
Bakersfield, California, from Pipe Line to Port Costa Sp. Gr. 970-14.1 B., Flash 260 Deg. F.
"Mexican Petroleum, from the Texas Oil Co., Sp. Gr. 938-19.5 Deg. B., Flash 239 Deg. F.
"Producers Crude No. 1 Fuel Oil" Union Oil Co., California, Sp. Gr. 959-16 Deg. B., Flash 174 Deg. F.
Tank Steamer "Santa Barbara" Sp. Gr. 962-15.7 Deg. B., Flash 280 Deg. F.
Sun Co's Louisiana Sp. Gr., Sp. Gr. 936-19.8 Deg. B. Flash 275 Deg. F.
Avon Refinery "Associated Oil Co., California, Sp. Gr. 953-17.1 Deg. B., Flash 159 Deg. F.
Gulf Refining Co's Navy Standard Oil U.S.S. Perkins, Sp. Gr. 897-27.5 Deg. B., Flash 180 Deg. F.
Gulf Refining Co. Navy Contract-Sp. Gr. 882-29.5 Deg. B., Flash 170 Deg. F.
Richmond California
California Standard Oil Co.
Beaumont Texas Gulf Refining Co. Sp. Gr. 907-24.8 Deg. B., Flash 272 Deg. F.
Standard Mexican Gas Oil, Sp. Gr. 856-34.2 Deg. B., 151 Deg. F.
Gulf Refining Co. Navy Standard Oil U.S.S. Perkins, Sp. Gr. 855-28.7 Deg. B., Flash 182 Deg. F.
Camden Chemical Co. By-Product of Coal Tar
Standard Star California Sp. Gr. 917-23.9 Deg. B., Flash 180 Deg. F.
Star California, Sp. Gr. 917-23.9 Deg. B., Flash 180 Deg. F.
Lot No. 4
Sty "Lima, Ohio Crude Oil, Sp. Gr. 901-24 Deg. B., Flash 222 Deg. F.
Sty "Lima, Ohio Crude Oil, Sp. Gr. 880-28.6 Deg. B., Flash 144 Deg. F.
Sty "Lima, Ohio Crude Oil, Sp. Gr. 890-26 Deg. B., Flash 158 Deg. F.

FIG. 1. TEMPERATURE VISCOSITY DIAGRAM OF FUEL OILS, REPR ODUCED FROM CURVES OF LT.-COM. JOHN J. HYLAND, U.S.N., WITH ADDITIONS (SHOWN IN DOTTED LINES) BY E. H. PEABODY.

the oil from which the lighter constituents have been distilled off. Though the Mexican oils are, as a rule, heavier and contain less of the lighter constituents than American oils, even they are now

*From a paper presented at a joint meeting of the Louisiana Association of Members of the American Society of Civil Engineers and the New Orleans Section of the American Society of Mechanical Engineers.

Fuel Oil Classification

Fuel oils may be classified according to several of their characteristics, which are more or less dependent upon each other. Some of these are the flash point, or temperature at which an oil will give off inflammable vapors; the viscosity, which may be explained as the molecular friction; the specific gravity, the heat value, and the sulphur content.

consideration in the actual burning of that oil, because the success of the burner or atomizer depends largely on its ability to atomize the fuel into sufficiently fine particles to insure satisfactory combustion, and the more viscous the oil the more difficult this atomization. There are various methods of expressing the viscosity, one of the most used being in terms of the Engler scale. Degrees

Engler means simply the ratio of the time it takes a given quantity of an oil to flow through a standard orifice as compared to the time it would take the same volume of water to flow through. Oil is usually sold, however, on the basis of its specific gravity (generally measured in degrees Baume) and its heat value and moisture content. It is usually assumed that the heavier an oil in degrees Baume, the more viscous is that oil, but this is not always strictly true.

Through the courtesy of E. H. Peabody, Mem. Am. Soc. M.E., in Fig. 1 is reproduced a very interesting chart giving the characteristics of some thirty different oils. This chart gives the temperature-viscosity diagram of these fuels, the specific gravity, the degrees Baume and the flash point. Comparing two crude oils from these curves brings out the relation, or rather lack of relation, between degrees Baume and degrees Engler:

	Deg. B.	Flash Pt.	Deg. Eng. at 230 Deg. Fahr.
Panuca Crude	13.7	140	13.75
No. 18 California.	12.7	285	5.2

It is to be regretted that oil is not specified in terms of specific gravity instead of degrees Baume, because in any calculations involving the weight of the oil per gallon or per barrel it is necessary to refer back to specific gravity. Further, the heaviest oil that can be designated on the Baume scale for liquids lighter than water is 10 deg. B., or unit specific gravity. There are oils being used now of 10 and 12 deg. B., and no doubt still heavier oils will be used, which will call for two different Baume scales and cause confusion.

Spindle Top oil has a specific gravity of about 0.92, corresponding to 22 deg. B., and its heat value averages about 19,700 B.t.u. California oil is somewhat heavier, the average grade of that oil having a specific gravity of about 0.95, or 18 deg. B., heat value about 18,500 B.t.u. The Mexican oils vary considerably in specific gravity and heat value, but as a rule they are much heavier than either the California or Texas oils; a typical oil now used has 0.99 sp. gr., or 12 deg. B., with a heat value of about 18,200 B.t.u.

Table I compares the prices of coal and oil, taking as a basis coal of the quality of Pratt, Alabama, and Pittsburgh coal, sold in the New Orleans market. While with these coals an evaporation of 10 lb. from and at 212 deg. can be realized with well-designed water-tube boilers when the boilers have ample heating surface and are in the hands of skillful firemen, it is extremely doubtful if any boilers in regular service are showing better than 8 lb., and the great majority are below this figure. Therefore, if we take 8 lb. as a basis, we are giving the coal its full value. Now, with oil giving 19,500 B.t.u. per lb., an evaporation of 14.5 lb. should be readily obtained if the apparatus for supplying the oil to the furnaces is of first-class design and if the furnaces are properly arranged. With this ratio as a basis, it is apparent that a pound of coal is equivalent to 8/14.5 or 0.541 lb. of oil. A barrel of crude oil weighs approximately 325 lb., therefore one ton (2000 lb.) of coal is equivalent in practical heating value to 3.34 bbl. of oil.

TABLE I—COMPARISON OF PRICES OF COAL AND OIL.

Coal, Dollars per Ton, 2,000 lb.	Oil, Dollars per Bbl.	
5.00	1.50*	1.66†
4.75	1.43	1.60
4.50	1.35	1.50
4.25	1.28	1.42
4.00	1.20	1.33
3.75	1.13	1.25
3.50	1.05	1.02
3.25	.98	1.01
3.00	.90	1.00
2.75	.83	.92
2.50	.75	.83
2.00	.60	.66
2.25	.68	.75

*Not allowing for labor saving.

†Assuming 10 per cent. of cost of fuel in labor of firing and handling ashes saved by using oil, a conservative estimate for plants of over 300 h.p.

An interesting point to note with reference to the heat value of an oil is that the B.t.u. usually given is the high heat value or heat value determined in a bomb calorimeter. The actual heat value available in a boiler furnace is less because all fuel oil contains a considerable percentage of hydrogen, and the latent heat of the steam formed by the combustion of this hydrogen passes up the stack as waste heat.

In all the heavier grades of fuel, particularly the Mexican oils, water mixed with the oil is in the form of an emulsion and will not settle out in a tank as it will with the lighter American crudes. This is not so much a disadvantage as it would seem, other than causing a lowering of the heat value. With an oil light enough for the water to settle out of its own accord, this water will frequently accumulate in the tank and piping and go over into the burners in a slug, putting the burners out; but with heavy oil a very considerable amount of water can go through the burner with no bad effect. The writer is inclined to believe that a small quantity of water in heavy oil is an advantage in that these oils are usually heated above the boiling point of water to effect atomization, and the vaporizing of the moisture in the oil as it leaves the burner tip probably helps to atomize the oil more thoroughly.

Oil Advantages Over Coal

Oil has numerous other advantages over coal than cost of fuel. The storage space required is much less for an equal number of heat units; there are no ashes to be disposed of; less boiler-room help is required for firing; the wear and tear on the furnace lining is smaller because the firedoors do not have to be opened, with the consequent chilling of the hot brickwork. Very few repairs are necessary to the grate bars; a much smaller stack can be used for the same boiler horse-power; the boiler can be forced with natural draft considerably beyond what it can with coal, an important feature where boiler capacity is scant; where feedwater is bad, it is often possible to carry a load with two oil-fired boilers which would require three boilers were coal used, thus allowing the cleaning and repairing of one dirty boiler at a time. Steam can be raised much more quickly and with no loss due to banking fires. It takes about 10 per cent. of the fuel normally consumed by a boiler at rated load to keep its fire banked with coal. In case of an emergency the fire can be instantly extinguished; any one who has had to draw a hot coal fire in an emergency can appreciate this particular advantage.

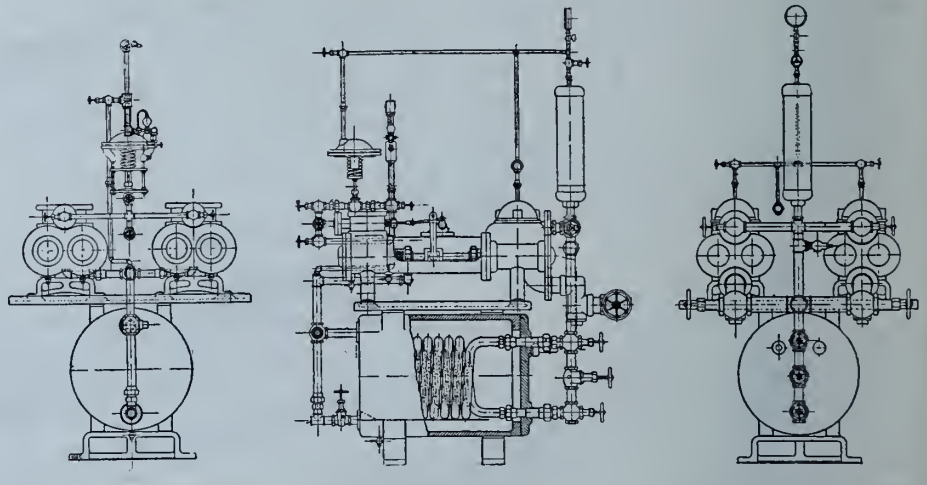


FIG. 2. OIL PUMPING SET, SHOWING DUPLICATE PUMPS WITH PRESSURE GOVERNOR, AIR CHAMBER, GAUGE, SUCTION STRAINERS, RELIEF VALVE AND HEATER.

Successful Oil-Burning Installation Data

There are several factors entering into the successful oil-burning installation, some of which affect the reliability of the system and others its efficient operation.

The first consideration for reliability is the oil supply to the burners, involving the storage tanks, pumping outfit, and heaters. The size of a storage tank varies, of course, with the size of the boiler plant, but it should be large enough, at least, to hold a carload of oil. A very popular size of tank is a 10,000-gal. tank, which is about 8 ft. in diameter and about 30 ft. long. These tanks are usually built of ¼-in. steel with ⅜-in. heads, though if the tank is subject to corrosion from the outside it should be made of heavier material. The tank should be equipped with a manhole and filling pipe, a suction opening, a vent opening, and openings for steam-heating-coil connec-

tions. The insurance requirements call for the tank to be below the level of the pumps and burners, which means that it is usually buried in the ground.

The Oil Pumps

The oil pumps are the next consideration. The pump that has given the best results is a duplex steam pump, piston-pattern type, with brass valves, metallic packing in the oil piston and special gaskets and piston-rod packing. The size of pump should be based on a very low piston speed.

The pump should be fitted with an air chamber on the discharge side to steady its pulsation of pressure, and a governor on the steam end to maintain the pressure constant. The pressure at which the oil is delivered to the burners depends largely on the character of the oil, varying from 40 lb. for oil of 26 to 30 deg. B. to 80 lb. for oil of 12 deg. B. The pump should also be equipped with strainers on the suction side to keep trash from getting under the pump valves. Duplicate pumps should always be installed, so that if anything goes wrong with one pump the other may be put in service.

The pump should be set as near the level of the oil as possible to give the minimum suction lift, and the suction pipe should be as straight as possible, preferably with bends instead of elbows. Where the suction pipe is long, a foot valve at the bottom of the suction line in the tank is desirable. This should be a valve without leather seats, as fuel oil deteriorates leather. A very good valve to use is a horizontal-swing check used in a vertical position. In addition to air chamber and governor, the pump should be equipped with a relief valve set at a pressure heavier than the working pressure, so as to minimize the danger of breaking the pump. This relief valve should be of the enclosed type, so that its overflow be returned to the tank.

The heavier oils require heating in the suction tank in order to enable the pump to lift them. The temperature must not be high enough to cause the oil to vaporize under the suction pull of the pump. The writer has found a temperature of 110 to 130 deg. about right for Mexican oil of 12 to 18 deg. B. According to Commander John J. Hyland, U.S.N. (*Jour. A. S. N. E.*, May, 1914), the viscosity of the oil had to be reduced to 375 deg. Eng. in order to obtain full capacity from a Blake pump. In order to gauge this temperature accurately, a thermometer should be installed in the suction line near the pump. If this suction line is long, or has several elbows in it, it should be made one or two sizes larger than the suction opening of the pump.

The Heater

The next question is that of the heater. Practically all the oil now burned as fuel requires heating in order to reduce its viscosity and facilitate atomization at the burner. There is a wide choice of heaters, but the principal considerations are, first, to have the heater of ample heating surface, and second, to be sure that this heating surface is all utilized. In heating oil with a steam coil in a vessel of oil there is a tendency to local heating; that is, the oil next to the coils may be very warm; but this heat is not readily transmitted to the adjacent oil, so that a heater in which the oil is kept in rapid motion over all the heating surface in the coil is apt to give best results.

There are several pumping sets on the market which combine all the requisites enumerated above in one self-contained unit. Fig. 2 shows such an outfit which, it will be noted, consists of duplicate pumps with pressure governor, air chamber, gauge, suction strainers on pumps, relief valve and heater.

Oil Heating Temperature

The temperature to which the oil must be heated naturally varies with its viscosity. For fuel oil usually burned in the South, a temperature from 180 to 220 deg. is satisfactory, the higher temperature being for oil of 12 deg. B. As far as we know, no experiments have been made to determine the degrees Engler to which oil must be heated, but judging from our experience and with the aid of the temperature-viscosity diagrams, we should say that about 8 to 9 deg. Eng. is the viscosity required for a steam-atomizer burner. It has been stated, however, that any oil which can be pumped readily can be atomized by a steam atomizer. After the oil is heated at the pump (and its temperature should be read by a thermometer permanently fixed in the discharge line from the pumps), care should be taken to keep the oil hot until it reaches the burner by proper covering of the pipes.

Burner Feature

More stress has probably been laid on the oil burner than on any other part of the installation, which has led to the belief on the part of people unfamiliar with the burning of oil that the burner is the whole thing, whereas, as a matter of fact, the burner contributes but a very small part to the success of the installation. The term burner is really a misnomer, because the only function the burner performs is to atomize the fuel into sufficiently fine particles to effect complete combustion in the furnace.

For land installations, the type of burner which has proved best is the steam-atomizer burner with oil supplied to it under pressure. The essentials of such a burner are simplicity, cheaply renewable wearing parts, economy in steam for atomizing, and the production of a flame of such shape that makes good combustion and, hence, high boiler efficiency possible. The burners may be of either the round-flame or flat-flame type. The flat-flame type is preferable because it uses less steam for atomizing and produces a flame of such shape as to permit proper mixture of air to support combustion without excess air, which is not the case with a round-flame burner.

The use of a target wall is not necessary, and may cause injury to the heating surface of the boiler by causing the flame to concentrate on a small portion of the surface, resulting in what is termed "blow-pipe" action.

The general type of flat-flame burner is a tip in which are two narrow parallel and horizontal slots, the oil flowing out of the upper slot in fan shape on to the fan-shaped jet of steam issuing from the lower slot.

The position of the burner depends largely on the type of boiler. For a boiler with a long unobstructed furnace, such as a horizontal return tubular, or a boiler of the Heine or Erie City type, a burner set in the firing door is very satisfactory. For boilers where the furnace is short and the travel of the gases is upward, such as in the Babcock & Wilcox or Stirling boiler, the best arrangement is to put the burner at the back, shooting toward the front of the boiler. In either case air should be admitted to the furnace through a checkerwork of firebrick laid on the grate bars. The shape of this checker work should approximate the shape of the flame and thus reduce excess air, and the area of all the holes should be equal to 4 sq. in. per boiler horse-power.

Steam and oil connections to a burner should be made to allow for the expansion and contraction of the oil and the steam headers, and should have unions above and below the burner to enable the latter to be taken out quickly for cleaning. A very essential point in installing a burner is to see that it gets dry steam. The simplest way to do this is to take the steam from the top of the auxiliary steam header. A steam connection should be provided on each burner for blowing the oil out of the burner when it is shut down, as otherwise this oil will carbonize, due to the heat radiated from the hot furnace.

The principal consideration affecting the efficiency of an oil-burner installation, other than the choice of a burner economical in the use of steam (and giving the proper shape of flame), is the proper control of the air supply. One of the advantages of burning oil, mentioned above, was the possibility of reducing the excess air to effect combustion. Conversely, one of the principal losses is the ease with which excess air can be admitted. For any particular installation (assuming the setting is tight and checkerwork properly arranged), the best draft should be determined by installing a draft gauge on each boiler connected to the furnace, then gradually closing the damper until there appears just a faint trace of black smoke at the stack, and finally maintaining the draft at that point. It should be noted, however, that there can easily be smoke with excess air for two reasons: first, if the checkerwork is not properly arranged in the furnace there will be excess air, even though the combustion be incomplete, and second, poor atomization of the oil at the burner will give a grayish-white smoke, which is often mistaken for insufficient air. A more accurate method of gauging the air supply is to make periodical analyses of the stack gases and keep a record of the stack temperatures. The stack gases should not be over 100 deg. hotter than the steam, and no difficulty should be experienced in getting 13 to 14 per cent. CO_2 in regular operation.

REFRIGERATION DEPARTMENT

SAFETY IN REFRIGERATING PLANTS

THE ever-increasing congestion in our large cities, is one of the most potent of the causes of the rapid development of the artificial ice and refrigeration industry. If a hotel manager a generation ago had been asked to serve fresh vegetables in midwinter, he would have had considerable difficulty in complying with the request; but fresh vegetables are now available at practically all seasons of the year, at a cost within the means of persons in moderate circumstances. This is only one of the many items that have made the refrigerating industry possible, and because of this industry many things that were luxuries a few years ago are now considered to be necessities. Perishable food must be preserved in a suitable condition to provide the necessities of subsistence for the public, and especially for that part of the public that lives in the congested sections of our cities. These persons have neither space nor facilities for preserving large quantities of food stuffs, and must therefore depend on the dealers, both wholesale and retail, for their daily supplies. Under this arrangement the dealers must keep a comparatively large stock constantly at hand, and in order to guard against loss they must have refrigerating plants of their own, or must depend on natural or artificial ice, to maintain their establishments at proper temperatures.

There are in the United States over 12,500 ice-making plants, having an aggregate annual output of about twenty million tons. This does not include the thousands of private refrigerating plants in small restaurants, meat markets, grocery stores, and private dwellings. The principles of artificial refrigeration are being applied in more than 150 different industries, including among others, mining, paper making, woolen and silk manufacturing, laundering, and tobacco manufacturing, says the "Travelers' Standard."

Refrigerating Plant Hazards

As might be expected, an industry in which chemicals and highly-compressed gases are used in connection with tanks, piping, and moving machinery, is not immune from accidents. The growth of the refrigerating industry, employing high-pressure gases with the attendant risk of explosions and other accidents, is attracting the attention of municipal authorities to such an extent that regulations for installing and operating the plants have been drawn up and put into effect in many localities. No doubt these regulations will have to be revised as experience is gained in their application, and in this respect they may be expected to have a history similar to that of analogous regulations applying to steam boilers.

The fact that municipal authorities are taking steps of this kind in connection with the refrigerating industry indicates a growing public appreciation of the importance of the hazards pertaining to it. As in almost every other industry, the majority of the accidents that occur are avoidable, provided sound engineering principles are followed in the design, installation, and operation of the plants. It follows, then, that the engineer who designs the plant, and the man who supervises the installation, should bear in mind the question of safety; and it is equally important to place competent men in charge of the operation of the plants, because the judgment and ability of the men who supervise the work are exceedingly important factors in preventing accidents.

Ammonia Leakage

Leaks in a refrigerating plant usually occur at the gaskets or through cracks in pipes or other defective parts of the apparatus under pressure. Very often such leaks have no other consequences than the loss of a certain amount of ammonia; but when the defect is of such a nature as to allow large quantities of ammonia fumes to escape, more serious results often follow. For example, if there are arc lamps or open flames in the room, or a free connection between it and the boiler room, the mixture of ammonia, hydrogen, and oil-vapor and other volatile impurities may ignite and fill the whole compartment with flame for a short time, with serious consequences to anyone who may be present. The fire hazard from this cause may be practically eliminated by using electric incandescent lamps, and installing self-closing doors between the boiler room and the rooms where leaks are likely to occur.

A leak of sufficient size to quickly fill the engine room with ammonia fumes is exceedingly hazardous to the employees. A very brief exposure to the fumes would be sufficient to overcome persons in the room, and unless immediate assistance were given, death from suffocation would quickly follow. It is essential, then, that the system be arranged in such a way as to permit the employees to shut off the ammonia supply quickly, from any one of three or four widely separated points. In addition to this, oxygen helmets should be distributed about the room at convenient places, so that the employees may procure them quickly in case a leak or rupture accurs. Equipped with these helmets, the men will be immune from the dangers of the fumes for a short time, and will be able to make temporary repairs.

Air Pressure Test

It is customary, when installing a refrigerating system, to test it under air pressure before it is charged with ammonia. This practice is commendable if it is properly carried out; but if it is done in a careless manner, by inexperienced men, it may result disastrously. The principal sources of danger are those due to a break of some defective part of the system, or an explosion brought about by the ignition of oil-vapor or other inflammable impurities. The various parts should be tested by the manufacturer before shipping to the point of installation, and they usually are. Shocks received during transportation or installation may cause a defect in some part of the system, however, and the points may also be poorly made. For these reasons extreme care should be taken to guard the workmen during the test.

It is customary to lubricate the cylinder walls of the compressor with oil before starting the test, and more or less of this oil is forced into the piping by the compressor, and collects in pockets. As the pressure is increased, more and more heat is generated, the oil vaporizes, and if the rise in temperature is sufficient, an explosion results. Lubricating oil having a low chill-point is desirable for regular use in refrigerating plants; but most oils that fulfil this requirement have a low flash-point also, and they are therefore dangerous to use in an air-pressure test. Low chill-point oil is not so essential as high flash-point oil during the test, because the higher the flash-point the less is the danger of explosion.

A thin coating of lard oil should first be applied by hand to the walls of the compressor cylinders, and the compressor allowed to run until the pressure reaches 100 lbs. or more. The compressor should then be stopped long enough to cool down after which it should be started up again and operated until forty or fifty pounds of additional pressure is obtained. It should then be stopped again, and when sufficiently cooled it should once more be started, but at reduced speed, and stopped whenever the discharge pipe becomes hot enough to be uncomfortable to the hand. If these precautions are taken there is little chance of an explosion from internal causes during the test. The men should be kept away from the apparatus as much as possible, however, as

there is always a possibility that an accident may occur through the failure of an imperfect joint, or from unforeseen weakness in some other part.

Pipes less than two inches in diameter should not be used, except in single lengths. Pipes of smaller size than this are usually butt-welded, and are bent to the desired shape instead of being made up with fittings; and it should be remembered that there is always a possibility than an imperfect weld or an imperceptible crack will open during the bending process, when long pipes of small diameter are used—particularly if the bend is at or near the weld. No matter what size of pipe is used, it should be properly supported, and should be installed so that it will not be subject to shocks from any source whatever.

Operation Carelessness

Carelessness is just as dangerous in a refrigerating plant as in other industries. An operating engineer who neglects to open the valve in the pipe connecting the charging pipe and the shipping tank containing the ammonia, at charging time, shows gross carelessness, and a man of this type is likely to hasten the charging operation by applying hot water or steam to the shipping drums. Naturally, the heat thus furnished will increase the pressure in the drum to which it is applied, and if the valve is closed there is no means of relieving the extra pressure except by an explosion.

At this point it is well to call attention to the great importance of keeping all valves in the plant in good operating condition. There are many valves in a refrigerating plant that are seldom used. The mere fact of their presence indicates that they have been installed for some purpose, but their usefulness is questionable (or, rather their uselessness is a certainty) if they are not regularly inspected and tested. Rust in the stuffing-box gland and on the threads of the packing nut is a common source of trouble in a plant. The greater the accumulation of rust and the longer it remains, the harder it is to operate the valves; and when occasion arises to use them, after a period of neglect, it is often found that they act as if they were solidly cast in the piping.

Compressor Accident Classification

Compressor accidents may be divided into two classes: (1) those due to the breaking of some part of the compressor itself, and (2) those occasioned by conditions not inherent in the construction of the machine, such as unusual pressures, explosions, or the presence of liquid ammonia in the compressor. Accidents under the first class include the breaking of valves, piston rods, and rings, or the rupturing of cylinder walls and heads. Valve breakage is the most frequent cause of compressor accidents, and is due principally to unnecessary wear, improper cushioning, or deterioration of the metal. It is evident that careful attention to the materials of construction, and to the design and installation, are necessary in order to keep accidents of this class at a minimum. Accidents due to the rupturing of cylinder walls and heads are rare, and are usually attributable to faulty design and construction, or to a lack of proper consideration of shrinkage strains. Piston rings formerly caused considerable trouble, but ordinary snap rings are now used with satisfactory results, so far as accidents from this cause are concerned.

Accidents under the second heading are not very frequent, but they are likely to be much more disastrous. Those caused by excessive pressure may be avoided in considerable degree by requiring ample safety factors in the material, design, and construction of compressors. In addition to this, relief valves should be so installed that they will operate before an increasing pressure has reached the limit of safety. The discharge valve may accidentally be left closed and the machine started, and unless a relief valve has been installed it is certain that as the pressure increases something must give way. If a relief valve is installed in a by-pass, or in a connection made between the discharge-side pipe of the compressor in front of the stop-valve and the suction side of the compressor in front of the suction stop-valve, protection will be given against excessive pressure in the system as well as in the compressor.

However, carefully a system is designed and installed, a certain amount of liquid is likely to accumulate, and its presence in the compressor is always a source of danger. The obvious remedy is to provide a properly located relief valve, of sufficient capacity to permit the discharge of practically all the liquid present before the piston reaches the end of its stroke. There are cases where considerable difficulty may be experienced in equipping compressors with such devices, but the greater safety gained is well worth the trouble.

Every steam engine should be provided with a safety stop, wholly independent of the ordinary governor. In case the governor fails to work properly and the engine starts to "race," the independent safety stop is supposed to operate as soon as the speed exceeds a predetermined limit, shutting off the steam, bringing the engine to a standstill, and preventing the bursting of the flywheel and other serious consequences.

The operating engineer of a refrigerating plant should remember that he is subject to many of the hazards that are to be found in the ordinary power plant, and also to some additional ones. For example, in compressing air he should never use a machine that has recently been used to compress ammonia; and in opening gauge cocks he should stand at the side rather than in front of the gauge glasses. Such precautions as standing at the side rather than in front of cylinders or compressors, and refraining from calking pipes or tightening up fittings while they are under pressure, are generally understood, but often disregarded. It is particularly dangerous to calk joints or tighten nuts or fittings under pressure. Many fatal accidents have been caused in this way.

In the growth of any industry, dangerous situations arise that could not possibly be foreseen. This is one of the penalties of pioneer work. We have commented on some of the more common hazards in the refrigerating industry. No doubt as the industry grows, new conditions, some of them having considerable elements of danger, will arise. Refrigerating engineers should have this possibility in mind at all times, and by calling on past experience endeavor to keep down the number of unforeseen dangers.

HIGH SPEED AMMONIA COMPRESSORS

IN the March issue of the Journal of the American Society of Refrigerating Engineers, C. R. Neeson discusses the the reason for using high speed ammonia compressors, also the main features of their design. In regard to the latter he states that the only type of valve feasible is one consisting of a thin plate of special steel to cover a series of slots in the valve cage, which gives a maximum opening with a very small lift, thus allowing a rapid movement of the valve without shock or noise. As the valves must be accessible they are placed radially in the cylinder body at each end, suction valves at the top and discharge valves at the bottom. All valves are alike and interchangeable.

A new principle has been adopted in order to completely fill the cylinder to suction-pipe pressure. This consists of a series of ports around the centre of the cylinder casting which are uncovered by the piston at the end of the suction stroke when its speed is least and its acceleration greatest, and where the inertia of the gas in the suction pipe tends to build up the pressure at the cylinder. The length of the piston is about the same as its stroke. As there are no valve springs to overcome, it is possible in spite of the so-called high speed to fill the cylinder to the exact pressure in the suction line. Several diagrams exhibited go to prove this statement. These diagrams show that the pressure in the suction pipe at the beginning of the suction stroke is slightly above the pressure at accumulator, due to the inertia of a column of gas at high velocity which is stopped suddenly when the piston reaches the end of the stroke closing the suction valves.

Castor Oil.—A few years ago castor oil was the universal lubricant for both internal and external lubrication, but as engineers became more enlightened on the subject generally, for internal lubrication it was discarded. The principal reason why castor oil has been condemned for internal lubrication is the breaking up of the oil into several corroding acids when exposed to high temperatures. As a lubricant for external bearings, however, castor oil is still largely used, and the old school of mechanical engineers will not listen to anything against it.

Power House Plant and Equipment for Engineering Works

Staff Article

The provision of suitable power, light, heating and similar systems in a shop engaged in modern engineering work calls for a diversified equipment, each item of which must be capable of rendering satisfactory service day in and day out. It is a matter of interest to readers that so much of the equipment installed should be the output of a single firm.

AS builders of high-grade machinery products, the Goldie & McCulloch Co., Galt, Ont., has enjoyed an enviable reputation for sixty-eight years. As a firm, therefore, two of whose principal lines are engines and boilers, it was to be expected that they would generate their own power, light and heat, despite the possible economy attaching to the use of Hydro-Electric power and its great development in that part of Ontario surrounding the City of Galt. On the other hand, the installation of a complete power plant may be looked on as evidence of confidence in one's own product, with its opportunity for observation, experiment and improvement unhampered by any considerations save those pertaining to the operation of the works as a whole.

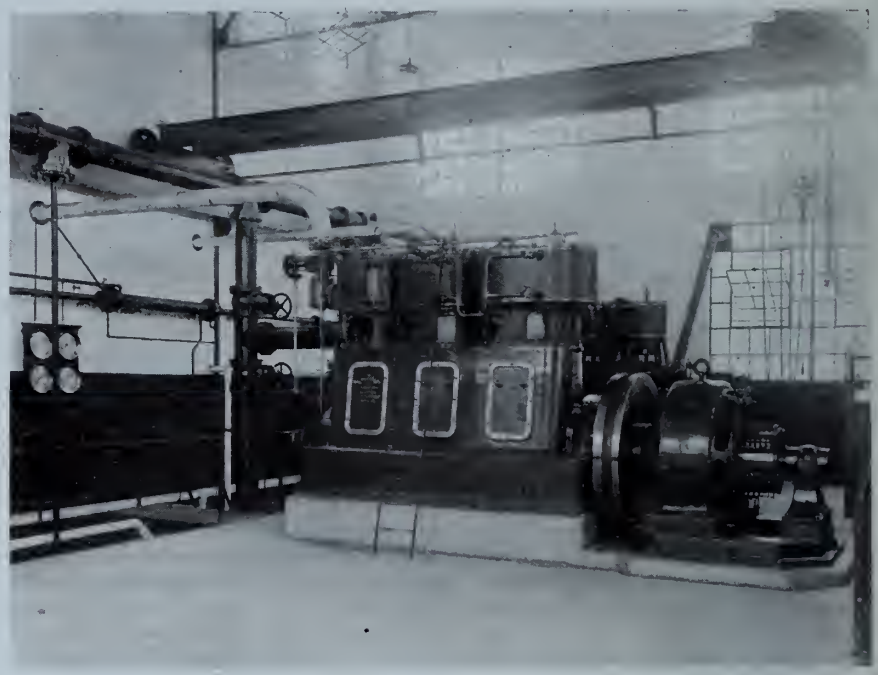


FIG. 2. 300 HORSE-POWER VERTICAL ENCLOSED ENGINE WITH WESTINGHOUSE D. C. GENERATOR.

Equipped With Own Product

The power house which forms the subject of this article has just been recently completed and is situated at the Co.'s South Works, giving the necessary service of electric power and light, steam power, pneumatic power and hot water heating. The entire installation, with the exception of minor accessory equipment, is the product of the firm's own shops and possesses peculiar interest thereby. which increases with a close study of the plant.

A side elevation of the plant is given in Fig. 3, which shows the principal features of the building, and the relative arrangement of the various items. A plan view is reproduced in Fig. 4, while a side elevation of the pump room, engine room piping and heaters is given in Fig. 7. The building is approximately 105 ft. by 60 ft., and is of steel and brick construction, the boiler room and bunkers being sunk 9 ft. 6 in. below the level of the engine room, an arrangement which facilitates the projection of the engine room roof above that of the boiler room, giving a semi-monitor effect which allows of light being received from all four walls of the engine room. The roof trusses are of steel construction supported by I beam columns, the latter being entirely built in with brickwork and hidden from view so that the interior effect produced is particularly pleasing, especially in the engine room, surrounded by a dark green dado extending 6 ft. up from the floor level, with white throughout above.

FIG. 1. "G. & McC." WATER TUBE BOILER, SHOWING MECHANICAL STOKERS, SOOT BLOWERS AND ASH-HANDLING EQUIPMENT.

Arrangement of Building

Three main divisions are formed in the building,—coal bunker, boiler room and engine room. The coal bunker is at the left of the illustration and is supplied from hopper bottom cars, the tracks for which are level with the ground outside. A spur line from the C.P.R. enables the cars to be brought conveniently to the building, the bunkers having a capacity of approximately three carloads in addition to one on the tracks.

Boiler Room

The boiler room is laid out so as to have ultimately four G. & McC. water tube boilers with a total capacity of 1,280 horse-power. At present two boilers of 320 horse-power each are installed, De-

troit mechanical stokers being fitted to each. Spanning the stoke-hold floor and of sufficient height as shown, is a small hand traveling crane with electric hoist and dumping bottom truck. By this means the coal is readily transferred from the bunker to the hoppers on top of the stokers, the ashes being elevated by the same device and deposited in a team wagon run in on a platform next the wall.

ous headers having easy curves to avoid any retardation of circulation. The parts of the boiler subjected to pressure are of forged steel throughout, the design, material and workmanship placing it on an equal footing with best types of boilers made in other countries.

sions. A steam driven Sheldon fan draws the hot gases through a smoke breeching between the boilers and the division wall, the fan being driven by a G. & McC. horizontal high-speed Ideal

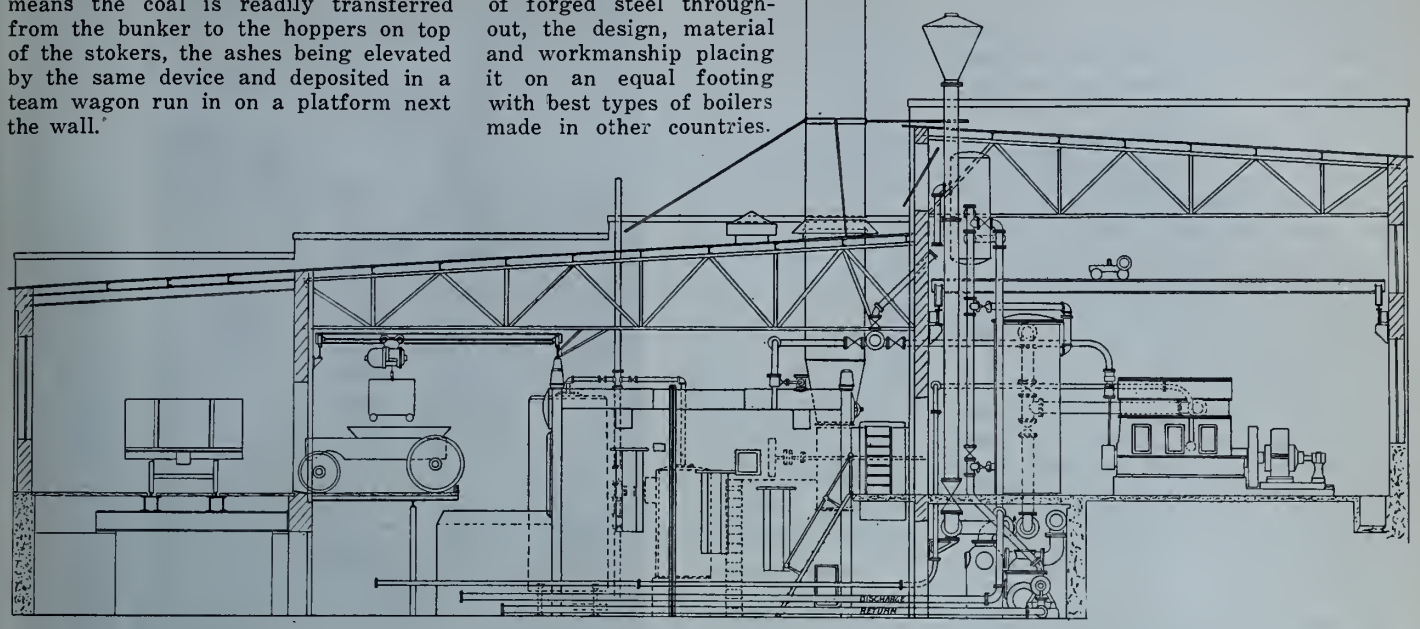


FIG. 3. SIDE ELEVATION OF POWER PLANT BUILDING SHOWING ARRANGEMENT OF VARIOUS UNITS.

Water Tube Boilers

The water tube boilers are of the Goldie & McCulloch sectional type which resembles in general appearance the ordinary type of sectional boiler, but which is provided with such important details as extra size nipples and rear circulating tubes, together with large sinu-

The working pressure of the boilers is 175 lbs. per sq. in. and G. & McC. superheaters of forged steel construction are fitted, a temperature of 530 degrees Fahr. being continuously available.

Induced draft gives ample control over combustion conditions and permits the use of a steel stack of moderate dimen-

engine. Access to the fan platform is had by a stepladder direct from the boiler room floor, and also by a stepladder from the engine room floor level along a gangway on top of the smoke breeching. This gangway also provides convenient access to the steam and super-heater valves.

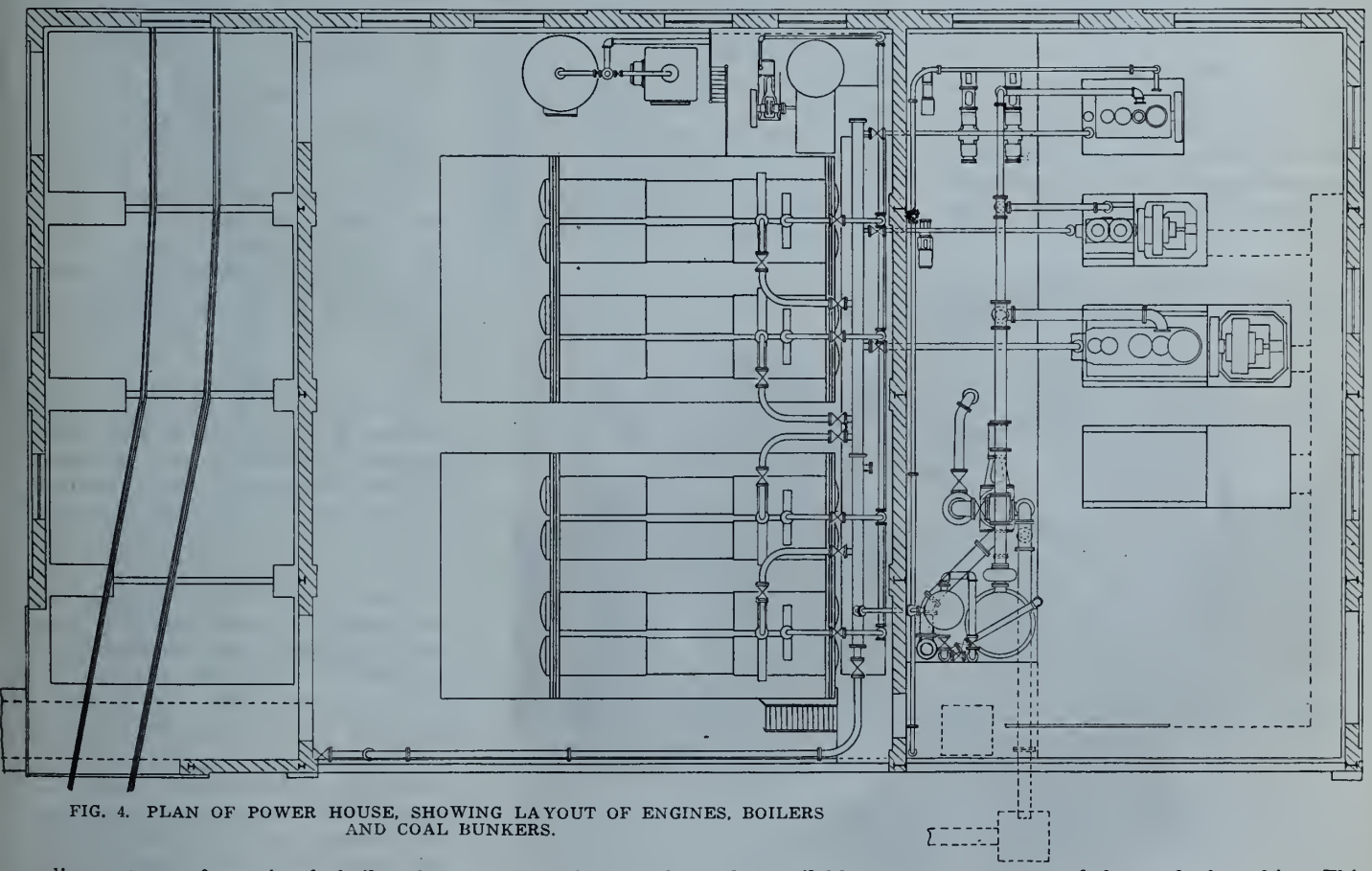


FIG. 4. PLAN OF POWER HOUSE, SHOWING LAYOUT OF ENGINES, BOILERS AND COAL BUNKERS.

Complete Valve Installation

A feature of the pipe arrangement is the very complete installation of valves to insure the utmost degree of control and safety, both under normal operating conditions and in case of accident. On the steam pipe from each boiler is an automatic isolating valve which closes in the case of a burst pipe or other emergency. Hopkinson-Ferranti stop valves are installed on the main and engine pipe lines, the isolating valves being also of Hopkinson manufacture. All of these valves, which are made in England, have cast steel bodies with valves and seats of "platnam" metal, and, together with their manner of installation, represent the most recent power plant practice. The steam header is extra heavy steel pipe with solid welded nozzles—made by the Walworth Co.

A result of careful designing of the piping is the entire absence of leaks even of minor proportions, this being due both to careful erection and the use of suitable packing to withstand the pressure and super-heat temperature; Calore packing is used exclusively throughout.

As shown in plan drawing Fig. 4, the boiler room occupies the main central part of the building, being 46 ft. wide. At the lower left hand corner of the boiler room, and passing across the end of the coal bunker, is a tunnel, 7 ft. high by 4 ft. 6 in. wide, through which pass all the service pipes and wires to the various factory buildings.

Water Supply

The ground on which the building is erected was underlain with solid rock, and the boiler room, pump room, bunker space and tunnel were excavated from this material. At the same time a boring was made in the pump room to a depth of 240 ft., from which water of excellent quality and low temperature is obtained in ample quantity. This water is used for boiler feed purposes, and is passed through an Ideal feed water heater of G. & McC make, an auxiliary heater of square form being installed alongside. As an addition to the purifying treatment to which the feed water is subjected in the heater, Perolin boiler compound is used, the internal condition of the boilers, due to the use of this preparation, being entirely satisfactory. Diamond soot blowers and Everlasting blow-off valves complete the accessory equipment.

FIG. 6. VIEW OF PUMP WELL LOOKING DOWN ON CONDENSER.

Engine Room

The engine room, as will be gathered from the line drawings and also interior view, Fig. 2, is particularly spacious, having a width of 35 ft. and occupying the entire right hand portion of the building. In the upper part of Fig. 2 can be seen the hinged glasslights which open above the roof of the boiler room, while the other sides are liberally provided with steel sash lights with ventilating sections. Repair and erection work is rendered easy by the installation of a 5-ton Herbert Morris overhead traveling crane.

Two electrical generating units and one air compressor are at present installed, with space sufficient to allow of more than doubling the present capacity. All of these units are steam driven, and run condensing.

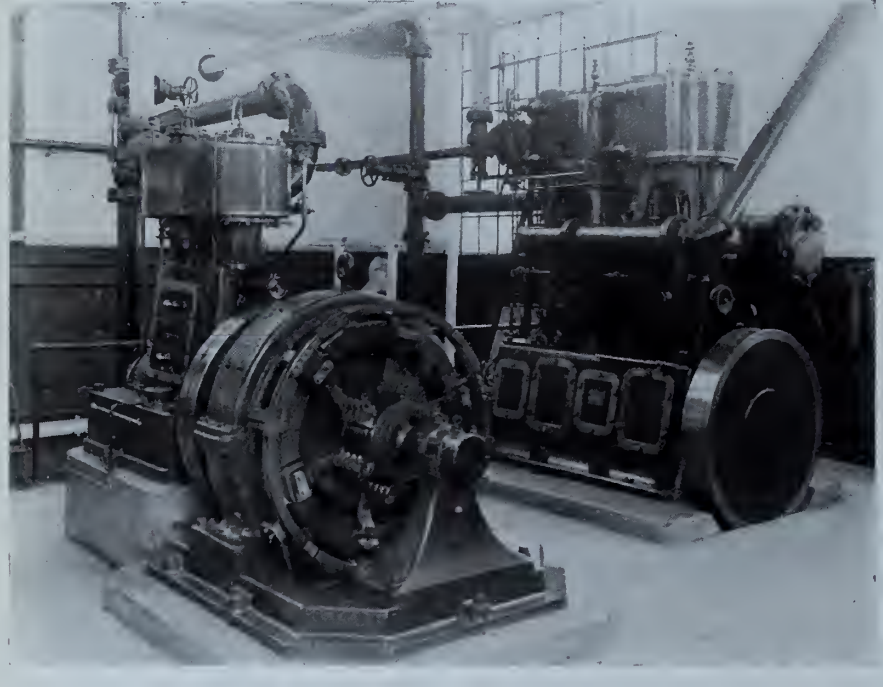


FIG. 5. SMALL POWER UNIT AND TWO-STAGE COMPOUND STEAM-DRIVEN AIR COMPRESSOR.

Main Unit

The main unit, see Fig. 2, consists of a Goldie & McCulloch triple expansion, vertical enclosed engine of the quick-revolution type, having forced lubrication. The cylinders are 12 x 17 x 25 in. dia. by 10 in. stroke, giving 300 brake horse-power with an overload capacity of 25 per cent. This unit is direct connected to a 200 k.w. Westinghouse d.c. generator and carries the main shop load.

The smaller unit consists of a compound engine of similar type, having cylinders 9 x 15 in. dia. by 7 in. stroke, running at 450 revs. per min., and giving 150 brake horse-power, with 25 per cent. overload capacity. It is direct connected to a 100 k.w. Westinghouse d.c. generator, and is used for night work, light loads, and as an auxiliary during heavy overload periods. The governing system employed on these engines is of the combined throttle and expansion type, and McCord lubricators are used for oiling the cylinders. Both engines are standard sizes as regularly produced by the builders and represent the highest development of the marine type as adapted to land conditions, their manufacture having been undertaken so as to keep pace with the rapid development of electrical machinery and the increasing demand for higher speeds and pressures. The forced lubrication system referred to is an outstanding feature of the design, every

bearing and pin, even to the governor pins, being fed with oil under a pressure of 15 to 20 lbs. per sq. in., all dust and dirt being absolutely excluded by the construction employed. Their operation is characterized by an absence of wear even over a period of years; they require a minimum of attention, are neat and compact in appearance, silent and practically vibrationless in running.

Air Compressor

Fig. 5 illustrates the smaller unit and also the air compressor. This latter machine is built by Alley & McLellan, Glasgow, Scotland, and is of the steam driven, vertical straight line type, the air cylinders being immediately above the crank case, with the steam cylinders above them. Compound expansion is used in the steam cylinders. The air intake pipe can be observed coming down from the engine room wall and passing along the side of the air cylinders, which operate on the two-stage system, air being drawn in on one side of pistons at atmospheric pressure and discharged into the intermediate receiver, the end of which can be seen in the illustration, from which it passes to the high pressure side of the same pistons and thence at 100 lbs. pressure to the air main which passes through the tunnel to the shop. The compressor operates at a speed of 300 revs. per min. and at this speed has a capacity of 650 cubic ft. per min.

When operating at slow speeds with an output less than its capacity, the compressor is controlled by a governor operated by pressure from the air main, acting on a relay piston in a cylinder carried by the main governor lever. When maximum demand and pressure is required, the main governor lever comes into operation in such a way that the relay piston is rendered inoperative and governing is direct from the crankshaft; this condition also obtains in the case of accident to piping, etc., which otherwise would let the compressor run away.

Condensing Plant

The condensing and heating systems will be understood by referring more particularly to line drawing Fig. 7, which also shows the boiler feed pumps and, at the left, the intercepting tank into which the condenser discharge is conducted. Two main exhaust pipes are provided extending horizontally as shown and into either of which one or all of the units can be made to exhaust as required. The lower pipe passes directly to a 1,000 horse-power standard G. & M. type of pet condenser, located close to the well and within a few feet of the same level as the water. This allows the water easy access to the condenser which maintains a vacuum of 26 in. in summer without difficulty. The level of the water in the well rises after rain to a height of 2 ft. above the floor, at which point it has very little further rise to make to enter the condenser.

The upper exhaust main passes through a Sheldon oil separator and enters a large tubular heater of the vertical cylindrical type from the bottom of which a pipe leads back to the condenser. An atmospheric exhaust is also provided for by a branch pipe from the lower exhaust main, running into the vertical exhaust pipe shown with exhaust head on top.

Shop Heating System

During the winter months the works are heated on the Evans hot water system, the water being heated by exhaust steam from the engines in the heater just referred to. The temperature is regulated to weather conditions by reducing the flow of exhaust steam to the condenser, thereby shunting the required amount of steam round through the heater. In winter weather a vacuum of 26 in. is obtained between the regulating valve and the condenser, with a varying vacuum in the heater, according to requirements. A table giving the proper degrees of vacuum to be maintained in the heater, according to weather conditions, is supplied to the engineer, who works accordingly.

Situated above this heater is a small auxiliary heater arranged to be operated with live steam from the boilers; this is used over week-ends, holidays and on such occasions as there is not sufficient exhaust steam available.

The hot water is circulated by a turbine driven centrifugal pump immediately below the main heater, the turbine being of G. & McC. manufacture, direct connected to a Rees-Roturbo pump made Manistee, Mich.

Pump Installation

Part of the pump room is shown in Fig. 6. The remaining equipment here in addition to the condenser and turbine pumps consists of duplicate sets of Goldie & McCulloch simplex boiler feed pumps, 12 x 8 x 12 in. of the outside centre packed plunger type, arranged to draw either from the hot well or direct from the artesian well. Also one piston pump of same make 8 x 5 x 10 in. which can be used for boiler feeding, and one service pump 8 x 5 x 10 in. which supplies cold water from the bore hole for drinking, washing and lavatory purposes.

Fire doors are provided between the various sections of the power house and sprinklers are installed in all locations where their use is desirable.

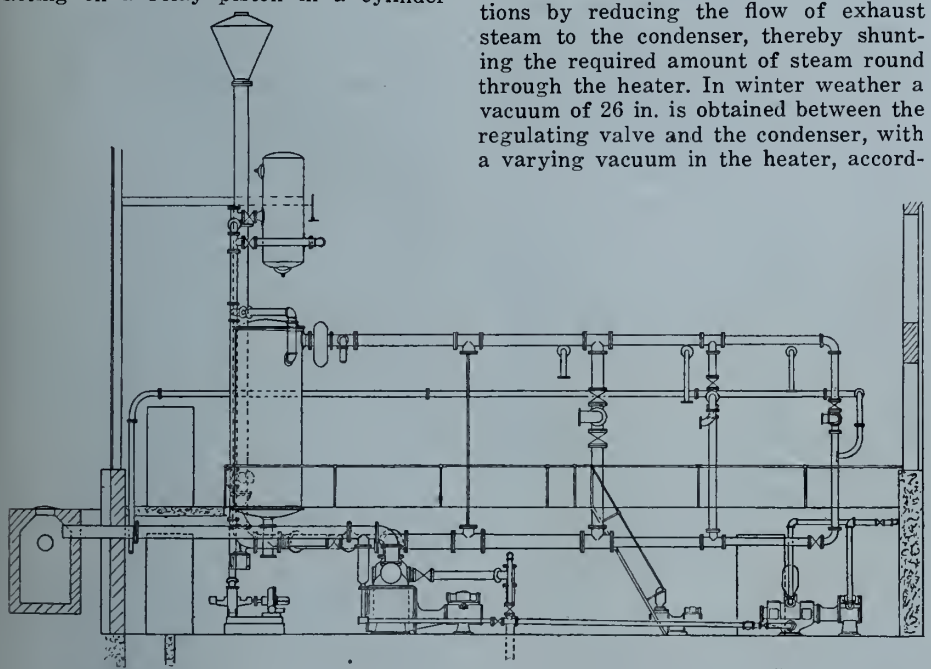


FIG. 7. ELEVATION OF PIPING, CONDENSING AND HEATING SYSTEMS.

BOILER SERVICE MAINTENANCE

A BOILER is in a dangerous condition when the plates, bolts, braces or rivets of which it is constructed become weakened to such an extent that the internal force or pressure equals the tensile strength of the material at the weakest section or sections. In this condition, strains due to varying temperature will cause rupture and an explosion, the volume and destructiveness of which would be in accordance with the size of the boiler and the pressure carried therein.

The moment a boiler is placed in service it gradually becomes weaker, due to the destroying forces continually acting upon it. These forces are of both a chemical and mechanical nature. Corrosion and oxidation are continually acting on the material from which a boiler is constructed, and take place both internally and externally, these processes being the two most serious and subtle causes of weakening to which a boiler is subjected. Evidences of these are most noticeable in the grooving and pitting of plate, and more especially at locations most subject to deposits of mud, scale and organic substances.

Expansion and contraction also play a very important part in the destruction and weakening of a boiler, more especially when concentrated at any one point, such as at sharp bends or flanges in the plates where the inner and outer sheets are subjected to different temperatures. Constant working or bending of bolts, flanges or angles, however slight, will sooner or later destroy the fibres in the material at points subjected to it, causing crystalization, cracking, and leaving same more susceptible to the chemical action of the feed water.

It is therefore obvious that only thorough examination by competent inspectors who understand the construction, nature of defects, and remedies to be applied, will maintain a steam boiler in safe working condition.

Electricity and Hydraulics

PLAYING HOSE STREAMS ON CHARGED ELECTRIC WIRES

FROM the earliest days of the adaptation of electricity to commercial purposes there has been, says *The Travelers Standard*, a more or less hazy notion that turning a stream of water on a live wire is a highly dangerous proceeding. Only a few years ago the statement was frequently made in the newspapers that firemen were hampered in their efforts to control a fire because of their fear of directing a stream of water on a high-tension circuit. Such a notice appearing in a paper to-day would reflect on the efficiency and standing of the particular fire department referred to. A study of the question has been made, with the result that every modern fire department has the necessary equipment to protect the firemen from shock. This equipment is in the form of rubber gloves and boots, insulated handles on the nozzles, a marline covering over all hose connections, or other equally effective insulating devices.

Probably the most authentic information on this subject may be had from the records of the fire departments in the principal cities in the United States. These fail to show that any fatal or even serious injury has been caused by directing a hose stream against a high-tension circuit, although a number of departments report that slight shocks have been felt by hosemen. This excellent record is accounted for in part by the fact that overhead circuits are seldom found having pressures above 30,000 volts, within the territory of the fire departments.

Hazard Determination Tests

The Pennsylvania Railroad Co. carried out a series of tests to determine the hazard involved in directing a stream of water on to a high-tension line. Three circuits were available for the purpose—one direct-current circuit of 525 volts pressure, one alternating-current circuit of 2,300 volts, and one of 4,600 volts pressure. Solid streams of fresh water from ⅝-inch and 1-inch nozzles were played on these circuits from various distances, and the difference in potential between the nozzle and the ground was measured by a voltmeter. The summarized results of these tests are shown in Tables 1 and 2. From these tables it is evident that a person standing ten feet away from circuits of the above-mentioned potentials runs no great risk of dangerous shock.

Table 1.—Voltage to Ground from a Five-eighths-inch Nozzle

Voltage on wire.	Distance from nozzle to wire.	Volts between nozzle and ground.
525 (D.C.)	7 ft. 5 in.	20
525 "	4 ft. 9 in.	38
525 "	3 ft. 7½ in.	60
525 "	2 ft. 2 in.	70
525 "	0 ft. 7½ in.	210
2050 (A.C.)	6 ft. 6½ in.	Static
2050 "	3 ft. 5½ in.	Static
4100 "	6 ft. 6¼ in.	Static
4000 "	3 ft. 5½ in.	Static

Table 2.—Results of Demonstration at Altoona.

Size of Nozzle	Voltage on Wire	Distance from Nozzle to wire (Feet)	Volts between nozzle and ground
⅝ in.	525 (D.C.)	3	Slight indications of static electricity to the hand
1 in.	2300 (A.C.)	8	Slight indications of static electricity to the hand
1 in.	4600 (A.C.)	10	Slight indications of static electricity to the hand

An important point brought out in connection with these tests is the fact that playing a solid stream from a hand chemical extinguisher on a high-potential circuit is an extremely dangerous proceeding. The difference in potential between the nozzle of a chemical extinguisher and the ground is approximately seventy-five per cent. of the difference between the line itself and the ground, provided the nozzle is held nine or ten inches from the circuit. Assuming a circuit of 3,000 volts and a nozzle ten inches away, the person holding the extinguisher would be subject to a shock from a potential of approximately 2,000 volts. It seems, then, that the stream from a chemical extinguisher does not offer the same resistance to an electrical current; or in other words, it is a better conductor than fresh water.

With nozzles of larger diameters and circuits of higher potentials the resistivity of the water largely determines the hazard to the men directing the stream. This fact was brought out by a series of tests made at Ohio State University, in which use was made of potentials ranging from 5,000 to 30,000 volts. Nozzles 1½ inches and 1⅛ inches in diameter were used, these being the two sizes generally employed by fire departments.

Increased Water Pressure Increases Resistance

One of the important points determined by these tests is the fact that an increase of water pressure increases the resistance, because it tends to cause the stream to break up at a shorter distance from the nozzle than when a lower pressure is employed. As the solid stream breaks up into separate drops the resistance rises suddenly, thus preventing the flow of electric current in dangerous potentials. It was found that with a 1⅛-inch nozzle the solid stream began to break up after travelling 15 to 17 feet, according to the water pressure, and with a 1½-inch nozzle after it had travelled 20 feet. This shows that for safety when playing streams on circuits above 5,000 volts, the hosemen, using 1⅛-inch or 1½-inch nozzles, should stand at least 20 or 25 feet respectively from the wires; and, in addition, at these distances all modern insulating precautions should be observed.

Overhead high-tension circuits within the fire department limits or near buildings are carried on poles 25 to 40 feet high, so that there is little danger that the firemen while standing on the ground will receive shocks through the streams of water directed on the circuits. Modern fire-fighting apparatus, however, includes metal ladders and extension towers, and it is quite possible for firemen working from either a ladder or a tower, to unintentionally bring the nozzle close enough to a high-tension circuit to receive a serious or fatal shock.

ELECTRICAL DRIVE FOR ROLLING MILLS

By O. C.

THE driving of rolling mills is one of the most difficult problems the electrical engineer has been called upon to solve. He has accomplished it quite successfully in a number of cases. The problem was an exceedingly difficult one even for the steam engineer; and the difficulty arises from the very quickly changing character of the load. Before the billet is entered between the rolls the only work the steam engine or the motor has to perform is the very trifling amount required to turn the rolls, along with the engine or the motor itself; immediately the rolls take hold of the billet the power rises to a maximum, which may be several hundred or several thousand horse power, according to the size of the rolls and the character of the work they have to perform. Immediately the billet emerges from the rolls on the other side, the whole of the power previously absorbed is set free, the engine or the motor now being required to furnish only the trifling power absorbed by the friction of the apparatus itself. The period of rest, however, as is well known, is very short, only sufficient to allow of the billet being re-entered between the rolls for the return pass; and immediately it is again entered and the rolls have gripped it, the power rises to a maximum, though usually not quite so high as the first pass; and this alternate no-load and full-load goes on until the billet has made all its passes; the power required being less at each pass, but being required each time for a longer period.

The first difficulty that confronted engineers in solving the problem was the question of meeting the requirements of the generating station. It is a very serious matter for any generating station to have sudden demands for very large currents, and still more for the station to be subject to the violent fluctuations of these demands. Most generating stations impose a limit upon power customers of the amount of current they may call for at any instant; and the reason is the outflow of a very large current from the generating station at any instant, lowers the pressure of the supply service for the time until the devices provided for meeting increased demand have time to operate. With the increased demand for current for power purposes, central station engineers have been gradually able to keep the lighting service free of the power service, and so they are able to allow larger calls on the power service than previously. But even where the power service is independent of the lighting service, the demand resulting from the insertion of a billet in the rolls of a large mill, would seriously lower the pressure of the service to all the other motors.

With modern methods of electric power distribution also over large areas by the aid of three phase alternating currents, heavy demands for current lead to somewhat serious induction troubles. The difficulty has been met in the same manner as with the colliery winding engine; in fact, the apparatus employed for driving rolling mills is a development of the electric winding engine. The fly-wheel again performs the useful office of absorbing the power that would be running to waste in the intervals between the different passes, and giving it out to aid the current taken from the service during the heavy starting and acceleration period. The interposition of the fly-wheel protects the electric supply service from the heavy demand that would otherwise be made upon it during the early portion of each pass. The full power released by the emergence of the billet from the rolls is not available to assist during the starting period, and therefore the economy to the user will not be so great as if he were allowed to take all the current he required directly from the service. On the other hand, if a central station did allow such an arrangement, it would be obliged to make higher charge for the current, and the cable employed to deliver the current to the rolling mills would require to be very large, or there would be a considerable lowering of the pressure at the motor, in addition to which, the drive would not run as sweetly as it does under existing arrangements.

NEW METHOD OF ARTIFICIALLY LOADING GENERATORS FOR TEST.

IN making tests on hydro-electric plants, it is quite frequently found necessary to provide artificial loads for the generators, says a writer in *The General Electric Review*. In such cases it has been the general practice to use a liquid rheostat formed by placing the electrodes in either the forebay or the tailrace, according to convenience, or sometimes in

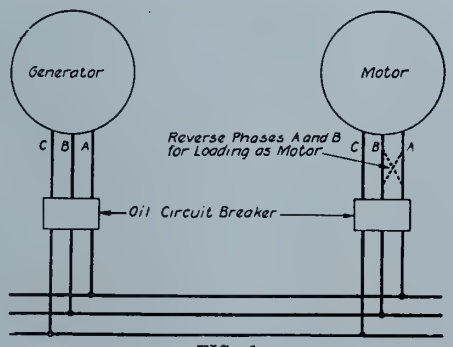


FIG. 1

a special tank with salt solution. Such an apparatus, besides having numerous troubles of its own, produces only a unity power-factor load; whereas the majority of generators are designed for operation at about 0.8 power-factor.

A scheme free from the objections to the liquid rheostat method was first made public in a paper on the Huronian Co. Power Development by Robert A. Ross and Henry Holgate, read before a joint meeting of the Mechanical and Electrical Sections of the Canadian Society of Civil Engineers, April 25, 1907. Since then the method has been used a number of times in various tests by R. A. Ross & Co., consulting and supervising engineers, of Montreal. Through the courtesy of J. Norman Smith, chief engineer of that company, the writer has been given the most important details from its experience; and these are now published for the benefit of any who may desire to use this method.

This same scheme was independently originated and successfully used by O. H. Ensign, Chief Engineer of the United States Reclamation Service, in testing the generators at the Cross Cut Hydro-electric Station, Salt River Project. With these exceptions, this method of loading generators does not seem to be as generally known as its merits justify.

The scheme is exceedingly simple, and consists merely in connecting another generator (when one is available), to the machine under test, with one phase reversed, so that the load generator runs in the opposite direction of rotation as a synchronous motor. When both machines are up to speed and are excited to full voltage, the gates of the wheel which is motoring are gradually opened until the required load is obtained, the wheel in this case acting as a water brake. The generator and motor fields may now be varied to produce any power-factor and voltage desired.

The following instructions prepared by R. A. Ross & Co. for the guidance of their men are of interest:

Instructions for Running Water-Wheel Generator-Motor Test

1—Transpose any two legs of the motor leads (this will reverse the direction of rotation of the motor; see Fig. 1. Say place B in A and A in B on the motor leads).

2—Close the main generator switches connecting the generator and the motor electrically together.

3—Excite both the generator and the motor.

4—Admit water to the generator wheel only, until both machines are turning over.

5—Note that the motor is operating in the reverse direction to that which it would operate as a generator.

6—Raise the voltage and the speed of the generator to normal by operating its field rheostat and by admitting water to the generator wheel.

7—Admit water slowly to the motor water-wheel to act as a brake, as required, to secure any desired load on the generator up to its wheel capacity.

8—Vary the field excitation on the generator and the motor to secure any desired power-factor.

9—The generator instruments will indicate the output of the generator; the instruments on the motor need not be taken into consideration.

10—If the exciters are directly connected to each generator and one exciter is not sufficient to excite the two machines, it will be necessary to reverse the exciter connection on the motor ex-

citer to suit the reversal of direction of rotation.

11—The governor mechanism should be disconnected from the motor, as it might be damaged by reversal of rotation, but an operator should be in attendance, to shut off the water to this wheel, in case of the circuit opening to the motor, when the water passing into the motor water-wheel would stop same, and reverse direction of rotation, causing it to speed up rapidly and possibly run away.

12—By actual operating conditions it has been found that quite a small gate opening on the motor water-wheel is all that is necessary to produce full load on the generator under test.

Troubles Experienced

A few of the troubles experienced by others are noteworthy. One most important point is to have the draught tube of the motoring unit filled with water before attempting to start; otherwise the hunting and surges set up by the wheel revolving against a load which is intermittent rather than steady may trip the oil circuit-breakers, or cause the machine to break from synchronism. On starting, the motoring unit cannot be started from its own wheel, as it would then run in the wrong direction. Usually two duplicate machines can be started together from rest, as described in the foregoing instructions; viz., by exciting both fields, connecting the armatures together, and admitting water to the generator wheel until it starts. The low-frequency currents produced in the generator armature will then drag along the field of the motoring unit and the two machines will run in synchronism from the start.

Trouble may occasionally be encountered due to high static friction in the bearing of one or both machines. This would necessitate opening the generator wheel-gate so wide, in order to "break it from rest," that the resultant large amount of water would cause the generator to accelerate too rapidly and it would break from synchronism with the motor. This may be overcome, in some cases, by starting the machine as a plain induction motor; i.e., by not exciting the motor field until it is partly up to speed. If this is not successful, the gates of both units may be opend just enough to start them turning over, without switching them together. As soon as the units start revolving, the gates should be closed and field applied to whichever unit is necessary to make them come to rest at the same instant. Just before they stop they should be switched together, fields applied to both machines, and the generator gate opened until they start together. This procedure will eliminate the high static bearing friction and no difficulty should then be experienced in geting started.

It is doubtful if much trouble will be encountered with horizontal units; but vertical machines, especially those equipped with Kingsbury or plate-type thrust bearings, are likely to be obstinate. It should be particularly noted that Kingsbury bearings are usually designed for one direction of rotation only, and some care must be taken when applying the test herein described to machines equipped with them.

The question may be raised as to what effect this method of testing will have on the water-wheels; whether impelling them directly against the flow of water will not result in strains and distortions that may be injurious. The writer has referred this subject to a number of the most prominent water-wheel builders in the United States, and very few have cared to make any very definite statements on this point. The consensus of opinion, however, seems to be that there is little question of harmful stresses in high-head wheels, but there may be some doubt as to low-head units. The writer would recommend conferring with the water-wheel builders in each individual case where this method of test is being considered. It is believed that when this method shall have become better known and more generally used, wheel builders will be less conservative about approving it.

THE HYDRAULIC RAM

IN response to an inquiry from one of our readers concerning the operation, etc., of the hydraulic ram, we have pleasure in reproducing an article covering same which appeared in our columns some years ago, believing that by doing so the information will be appreciated by others as well.

The principles underlying the construction and operation of the hydraulic ram were recognized as early as 1775 by John Whitehurst, who in that year communicated to the Royal Society a paper describing a machine of a similar type in which the overflow or waste valve was operated by hand. The next improvement was made by a Frenchman, Joseph Michael de Montgolfier. He was the first to see that the variable pressure, produced by changing the velocity of a column of water, could be utilized to operate the valve. Since that time, although numerous improvements have been made in the way of securing quick action of valves by aid of springs and weighted levers, the ram is essentially the same as in its earliest form.

A drive pipe A, Fig. 1, takes water from a source of supply H, to a chamber which contains the valve V. This valve, which opens inwardly, is called the waste or overflow valve. In another part of the same,, or communicating chamber, is a check valve V_2 which leads to the tank into which water is being forced and which has a water level considerably above that of the supply tank. When V_1 is opened, the column of water in the drive pipe is set in motion, and will finally attain a velocity which builds up a pressure under V_1 sufficient to close the waste valve. The energy of the moving mass in the drive pipe cannot immediately be dissipated, therefore, the pressure in the chamber rises and lifts the check valve, allowing some of the water to enter the air chamber W, compressing the air and forcing an equal amount of water into the tank C. When the water in the drive pipe comes to rest, V_2 closes, V_1 opens, and the cycle is repeated. The pressure may for an instant be slightly less than atmospheric, and advantage is taken of this to introduce a small amount of air through an air valve. This air replenishes any part of the supply in the air chamber which may be carried out with the water.

Although the ram may have a high efficiency, it is wasteful of water, and the form shown in section in Fig. 2 has been devised to pump pure water with a minimum of waste. Connection is made at A to the source of waste water, which may be any polluted water available. The connection to the potable water should preferably come from a source under slightly greater head than the impure water. In this ram the waste water consists mainly of that entering at A but, in part from that entering at I and, if the capacity of the space between the waste valve B and the check valve C is greater than the amount of water delivered per pulse, no impure water can enter the chamber D. In this ram the air valve is placed at E.

The hydraulic ram lends itself readily to variable demand, which can be met by either changing the weight of the waste valve or adjusting its stroke. Its greatest field is in the water supply for small towns where the cost of maintenance and attendance must be kept as low as possible.

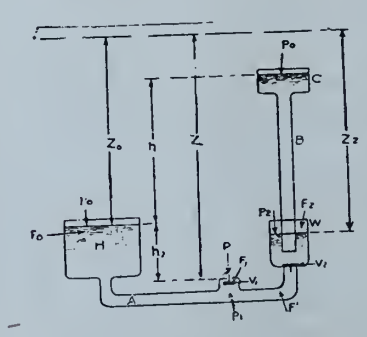


FIG. 1.—DIAGRAM OF OPERATION OF HYDRAULIC RAM.

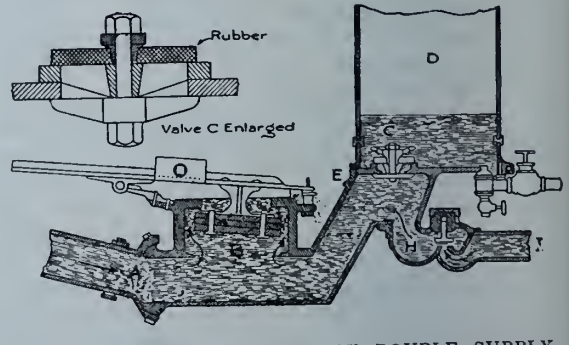


FIG. 2.—SECTION OF DOUBLE SUPPLY HYDRAULIC RAM.

C.A.S.E. Convention, Equipment and Supplies Exhibition

Arrangements are now well nigh complete for this annual enterprise, and judging by the efforts being put forth to secure a bumper attendance of operating engineers and power plant executives, the numerical response may easily surpass that of any previous gathering.

THE following provisional programe has been arranged for the annual convention of the Canadian Association of Stationary Engineers and Supplies Exhibition, to be held at Toronto from July 24 to 27 inclusive. Premises have been rented at 70 King Street West. The exhibitors will occupy the ground floor, while the first floor will be used for the convention sessions. It has been decided to keep the exhibition open each day, excluding Wednesday, July 25, which has been set apart for a trip to Niagara Falls, via Lake Ontario.

Tuesday, 24th

Convention opening by a member of the Board of Control. Smoker in the evening—boxing and music. Entertainments and outings for visiting ladies.

Wednesday, 25th

Boat leaves Yonge Street wharf at 9 a.m. for Lewiston, N.Y., where the trolley will be taken to Niagara Falls, N.Y., via the Gorge route. There the whole party will be entertained at luncheon by the National Association of Stationary Engineers. Before crossing to Niagara Falls, Ont., a visit will be paid to the Shredded Wheat factory. The return trip will take in the Canadian side of the Niagara River. Queenston Heights will be visited, following which, at 6 p.m., the boat leaves for Toronto, arriving there at 8.30 p.m.

Thursday, 26th

At 10 a.m., annual meeting of Exhibitors' Association. C. A. S. E. sessions. In the evening there will be an automobile trip round the city, and then to Scarboro Beach Park.

Friday, 27th

Closing day. No special feature arranged as yet.

The Exhibitors' Association executive this year is as follows:—Hon. President, H. P. Stevens; Past President, H. L. Peiler; President, Earl F. Hetherington; 1st Vice-President, Lloyd Archibald; 2nd Vice-President, C. N. Schragg; Treasurer, B. G. Newton; Secretary, Gordon Keith; Asst. Secretary, L. H. Rumage; Chairman Exhibit Committee, James E. Fiddes; Entertainment Committee, A. W. Crouch; Reception Committee, H. T. Ramshaw.

At one or other of the Grand Lodge sessions, the question of Graded Certificates for engineer operators in the Province of Ontario is likely to be fully discussed, and in view of the general unanimity existing as to the need that an enactment concerning them be placed on the Statute Book, a resolution will most likely be put and adopted for action by the Ontario Legislature.

Arrangements have been made for an open session, at which addresses will be given by Dr. Riddell, superintendent, Trades and Labor Branch, Province of Ontario, and by Louis Guyon and W. C. McGhie, chief examiners of License Board, Quebec and Ontario Provinces respectively; while papers will be read by D. M. Medcalf, chief of Boiler Inspection Department, Province of Ontario, on the History of Boilermaking in Canada, etc.; by W. G. Forbes, C.A.S.E. president, on Fans and Blowers, and by J. H. Hale, executive secretary, on the very important subject of Secretarial Efficiency.

LOOKS LIKE A BELT RECORD

AMONG the exhibits at the Centennial Exposition of 1876, says the "Compressed Air Magazine," was a 60-in. double leather belt, 187 ft. long, shown by J. B. Hoyt & Co., of New York. This was the widest and largest leather belt that had ever been made, and was intended for the Augustine mills of the Jessup & Moore Paper Co., of Wilmington, Del., to whom it was delivered early in 1877.

This belt transmitted 650 to 700 h.p., travelling over a 24-ft. diameter pulley on the engine to a 9½-ft. pulley on the line-shaft, at an engine speed of 52 r.p.m., or a belt speed of 3,920 ft. per minute, or 44.5 miles per hour. This mill operated continuously, starting at midnight Sunday and continuing in operation until midnight the following Saturday, so that the belt ran 24 hours per day, and averaged 300 days per year.

In 1902 the old belt had run 25 years, and in that time had travelled 8,010,000 miles, but its usefulness was by no means over. It always ran under damp conditions, because of its proximity to water, but notwithstanding these unfavorable conditions, when in 1908 it was sent to the factory to be cut into a 36-in. and other sizes. It was not rebuilt and there

1917 EXECUTIVE. C.A.S.E. EXHIBITORS' ASSOCIATION.

were no material repairs made upon it, and the same cement that was applied in 1876 is to-day holding the 36-in. belt together, and it has satisfactorily transmitted 350 h.p., equivalent to a working load of 198 lbs. per sq. in. of sectional area plus tension, from 1902. It is still running 144 hours per week, with prospect of several years more of usefulness in its present position. When the time comes for replacement, it will be possible to cut it up into smaller belts, which will probably be used successfully for many years in places where the performance is less exacting in its requirements, and these again, when their days of usefulness in the particular duty assigned them is over, may be cut into still smaller belts, and so on, and the final remains will have a value for heels and washers.

The longevity of this belt is not due to the lightness of its load, for its maximum transmission of 700 h.p. is equivalent to a working stress of 262 lbs. per sq. in., plus its tension—no small load; nor has it been due to superior care.

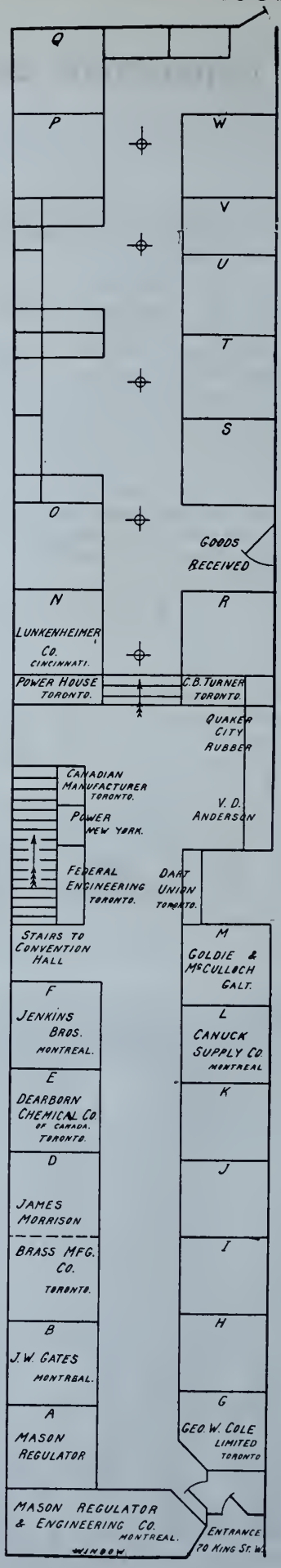
This belt, now operating over a 16-ft. engine pulley at 82 r.p.m. to a 6-ft. pulley on the main shaft, has a belt speed of 4,122 ft. per min., equivalent to 46.8 miles per hour, and in its present position in 15 years it has travelled 5,256,576 miles, which added to the distance which it travelled as a part of the 60-in. belt, equals a total of more than 13,266,576 miles with a probable considerable addition to be made to these figures by its subsequent performance.

The belt probably cost originally about $1,250. There has been expended upon it practically nothing for repairs, and the cost of transmitting 650 to 700 h.p. for 25 years, and 350 h.p. for 15 years, to say nothing of the transmission by the smaller belts cut from the original belt, has been $75 per annum for interest. The amortization of the original cost will be completed at an annual outlay of about $31, or a total cost of about $106 per annum; or disregarding the service rendered by the smaller belts, and averaging the loads with the years of service of the 60 and 36-in. belts at 570 h.p., this power has been transmitted at a cost of about 18c per horse-power per annum.

BOILER REPAIRS BY OXY-ACETYLENE

REPAIRS to boiler plates, which formerly were made by cutting a piece of the original plate out with cold chisel, and riveting a new piece on, are now being performed by Canadian firms with the oxy-acetylene process, the plates being cut with the oxy torch and the new pieces welded into place, doing away with riveting, which in many cases is largely impossible owing to lack of room. Oxy-acetylene welding for boiler repair jobs has been employed with complete success in the U.S., and has replaced the ordinary methods almost wholly in locomotive shops.

Copper Cliff, Ont.—The Canadian Copper Co. are building a pumping station for a sewage disposal plant.



LAYOUT OF C.A.S.E. EXHIBITORS' ASSOCIATION DISPLAY.

Screenings

Feared the Worst.—An Irishman coming out of ether in the ward after an operation exclaimed audibly: "Thank God! That is over!' "Don't be so sure," said the man in the next bed. "They left a sponge in me and had to cut me open again.' And the patient on the other side said: "Why, they had to open me, too, to find one of their instruments." Just then the surgeon who had operated on the Irishman stuck his head in the door and yelled: "Has anybody seen my hat?" Poor Patrick fainted.

* * *

Not Much to Ask.—The landlady bustled up to her new lodger as he came down to breakfast the first morning.

"Good morning, sir," she wheezed.

"Good morning," said the lodger.

"I hope you've had a good night's rest," said the landlady.

"No," said the mild-mannered little man. "Your cat kept me awake."

"Oh," said the landlady, tossing her head, "I suppose you're going to ask me to have the poor thing killed."

"No-no, not exactly," said the gentle lodger. "But would you very much mind having it tuned?"

* * *

Hoaxing a Bishop.—Funny stories are told about Archbishop Trench, who, seeing one day in Dublin a little girl trying to reach a door-knocker, came to her assistance.

"Rap hard!" said the little innocent. He did so.

"Now, run like the very devil!"

Trench always feared paralysis. One day at a dinner party he started probing his knee with his fork, and not feeling any pain, exclaimed: It's come at last, I am afraid."

"It's my knee," said the lady next to him!

* * *

The Scotch of It.—An enterprising drummer attempted to bribe an old Scotch merchant by offering him a box of cigars.

"Na, na," said the old chap, shaking his head gravely. "I canna take 'em."

"Nonsense," said the drummer. "If you have any conscientious scruples you may pay me a quarter for the box."

"Weel, weel," said the old Scot. "I'll tak' two boxes."

* * *

Hotel Advertising.—The customer at a London hotel gazed at his plate.

"Waiter," he called. "I should like to know the meaning of this. Yesterday I was served with a portion of pudding twice the size of this."

"Oh," said the waiter. Then, after a moment: "Did ye 'appen to be sittin' by the window, Sir?"

"Yes."

"Then that accounts for it," he said confidently. "We always give people by the windows large portions. It's a good advertisement."

Association and Personal

Horace N. Dorling has resigned from his position of inspector for the Imperial Munitions Board to join the sales staff of the Albany Pump Co., Toronto.

W. N. Campbell, who for 22 years was with the Reeves Pully Co., Toronto, has jointed the sales staff of H. W. Petrie, Ltd., Toronto, in the transmission department.

H. J. Matthews, general manager of the Quebec Street Railway, Heat & Power Co., died on July 3 at the Jeffery Hale Hospital, Quebec, from an operation.

George Beardmore, Toronto, and **W. G. Ross,** of Montreal, president of Asbestos Corporation of Canada, have been elected to the board of directors of the Canadian General Electric Co.

S. R. Parsons president of the British-American Oil Co., Toronto, was elected president of the Canadian Manufacturers Association at the annual meeting in Winnpeg last month.

W. R. Burge, who recently resigned as Toronto manager of the Jenckes Machine Co., is now a member of the Ontario sales organization of the Canadian Allis-Chalmers, Ltd., Toronto.

N. A. Marsh, of the John verMehr Engineering Co.'s engineering staff, Toronto, has left for an extended trip to Brazil, South America, to supervise the erection of the verMehr water filtration plant which is being constructed at Pernambuco.

Stationary Engineers Meet.—At the annual meeting of the Canadian Association of Stationary Engineers in the Temple Bldg., Toronto, the following officers were elected: President, H. Stevens; vice-president, S. Bamfrith; treasurer, John Brown; recording secretary, G. F. Moore; financial secretary, A. M. Wickens; conductor, H. Taylor; door keeper, W. Turner; delegates to the annual convention, J. Brown and S. Bamfrith; Alternatives, H. Stevens and T. Pope. The convention will be held in Toronto this month.

Lawford Grant has been appointed managing director and treasurer of the Eugene F. Phillips Electrical Works, Ltd., Montreal. Mr. Grant came to Canada in 1907 as president and managing director of the Canadian British Insulated Co., Ltd. In 1913 he accepted a position as assistant manager of the Phillips Co., and now succeeds **Geo. H. Olney,** who was head of that firm for eighteen years, Mr. Olney having recently retired owing to ill-health. Mr. Grant is a civil and electrical engineer, and was formerly engineer for the British Insulated and Helsby Cables, Ltd., of England.

Capt. T. E. Ryder, who has recently been promoted for distinguished conduct, is manager of the Canadian Fairbanks-Morse Co., St. John, N.B., on leave of absence for active service. Capt. Ryder has also been awarded the Military Cross, and on more than one occasion mentioned in despatches. He was, previous to the

CAPT. T. E. RYDER, M.C.

war, an officer in the St. John Battery. When war broke out he immediately enlisted for active service, and was attached to the Ammunition Column, Heavy Battery.

David Spiers one of the most prominent citizens of Galt, Ont., died there this month. He was 85 years of age, and had resided in Galt continuously since 1851, when he came to Canada from Scotland. He was at one time owner of the Galt Electric & Gas Light Co., until the advent of the Hydro system.

Brantford No. 4, C.A.S.E.—The members of this lodge met in their rooms, 17 George Street, on July 6. There was a good attendance, and what was perhaps of most importance, seventeen candidates were duly initiated. Election and installation of officers took place as follows:—Past president, John Lea; president, David L. Webster; vice-president, Joseph Ogle; recording secretary, Harry Doeringer; financial secretary, A. N. Matthews; treasurer, Fred. Owens; conductor, Thomas Hurst; doorkeeper, Wm. Powell. This lodge meets every Thursday evening throughout the year.

Kitchener, No. 9, C.A.S.E.—On June 24, the members of this Lodge, headed by Executive Vice-President, R. F. Goftn, Julius Luft, and Lodge Secretary, Conrad Ott, motored to Hamilton where they were met by Executive Secretary J. H. Hale who chaperoned them on a tour of the numerous places of interest to be found in the "Ambitious City." The Kitchener Lodge has been entrusted with the complete revision of the Ritual, Constitution, and By-laws of the Canadian Association of Stationary Engineers, and advantage was taken of the occasion to discuss questions relative to the revision that will be dealt with finally at the coming Convention. Not the least important of these are the issuance of Grade Certificates by the Association to its members, and the operation of its recent Federally enacted Bill of Incorporation.

OPERATOR ORGANIZATIONS

British Columbia Association of Stationary Engineers, Vancouver.—Subordinate Lodges at Vancouver, Victoria, New Westminster, Cumberland, Merritt, and Fernie.

North-West Association of Stationary Engineers, Edmonton, Alta.

Manitoba Association of Stationary Engineers, Winnipeg.

Canadian Association of Stationary Engineers, Hamilton, Ont.—Subordinate Lodges at Montreal, Toronto, Hamilton, Ottawa, Brantford, Guelph, Kitchener, Chatham, Ont.; St. John, N.B.; Owen Sound, London, Stratford, Belleville, Kingston, Sudbury, St. Thomas, North Bay, Port Arthur, Sarnia, and Windsor, Ont. The executive officers of the C.A.S.E. Grand Lodge are as follows:—

Past President.—Robert Dyson, Guelph, Ont.
President.—W. G. Forbes, Montreal, Que.
Vice-President.—Rodger F. Gofton, Kitchener, Ont.
Treasurer.—A. W. Heath, Hamilton, Ont.
Conductor.—William Cooke, Belleville, Ont.
Doorkeeper.—John W. Beasley, Chatham, Ont.
Secretary.—John H. Hale, Hamilton, Ont.

Boiler Setting Relative to Fire-Grate.—Considerable interest has been aroused among engineers as the result of experiment concerning and investigation into the setting of steam boilers relative to their firegrate. It has, I understand been conclusively proved that the hitherto accepted practice of having the heating surface most directly in contact with the heat of combustion from the fuel bed just as close down to the latter as possible, is much less efficient from a steam generating point of view than when the distance is twice or thrice that amount. It is just possible some of your readers have already had experience with boiler installations which exemplify the new type of setting—water-tube or return tube and, if so, it seems to the writer that no more opportune topic could meantime be profitably discussed in your columns editorially.—K.P.

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Vol. X. JULY, 1917 No. 7

PRINCIPAL CONTENTS

50 Years of Business Expansion 161-166
Design and Constructional Features of Turbine Pumps 167-176
Power Plant of the Canadian Kodak Co., Mt. Dennis.....177-182
"Spokes" in Industry's Wheel 183-184
William A. Sweet.
Sub-Station Equipped With Auxiliary Steam Plant.....185-188
The "Howden" Sectional Type Water-Tube Steam Boiler.....189-192
Power Transmission Section 193-196
Safety Standards for Power Transmission Machinery.... Handy Chart for Boiler Shell Computations....Bearing Lubrication....Power Transmission by Chain....Rope Transmission.
Practice of Oil Burning Under Stationary Steam Boilers.....197-199
Refrigeration 200-201
Safety in Refrigerating Plants....High Speed Ammonia Compressors.
Power House Plant and Equipment for Engineering Works....202-205
Electricity and Hydraulics 206-208
Playing Hose Streams on Charged Electric Wires....Electrical Drive for Rolling Mills....New Method of Artificially Loading Generators for Test....The Hydraulic Ram.
C.A.S.E. Convention, Equipment and Supplies Exhibition 209
General 209-210
Looks Like a Belt Record....Boiler Repairs by Oxy-Acetylene....Layout of C.A.S.E. Exhibitors' Association Display ....Screenings.
Association and Personal 211
Editorial 212
Fifty Years of Confederation.
The Operators' Point of View 213-218
Overcoming Trouble With Steam Pipe....Handy Spring Safety Valve Chart....Why the Radiators Would Not Heat ....Pulley Turning Rig....Fixing a Balky Valve....Last Resort on a Balky Lubricator....Handy Chart for Solving Fabric Belt in Plies....Hydraulic Air Compressor for Tire Service, etc....Specific Instance of Specific Gravity.
Operators' Instruction Course 219
Education Paper I.
Steam Power Plant Auxiliaries (Advtg. Section).....116-118
Boiler Feed Regulators II.
Trade Gossip, Catalogues, Book Reviews.....127-128

FIFTY YEARS OF CONFEDERATION

ON the first of the present month, the completion of fifty years of Confederation of the individual Provinces of this Dominion was consummated and, needless to say, the day was marked by celebration becoming the occasion. That we have progressed during the elapsed period, and are still doing so, is readily apparent, although when we look back—far or not so very far, is it surprising that we have reached our present status? When account is taken of the grit and dogged perseverance of the men from the Motherland who in the early days "blazed the trail," and with their immediate successors in many instances, made roads, built bridges, harnessed waterpowers, dug canals, pinned ribbons of steel to the soil and stretched it across a whole continent, initiated agricultural and mineral development, established manufacturing, built ships and sailed them on our lakes, rivers and ocean coasts, we in these later years must perforce admit that ours is a goodly heritage, not only to be cherished and retained intact, but to be developed in manner worthy of those from whom it has been received.

In the half century that has elapsed, much to be nationally proud of has been accomplished and, as might be expected, there has been and still is in evidence, much to the contrary. We are at war, and have been so for nigh three long years, and just what the new half century on which we are about to enter has in store is largely matter of conjecture. At war, yes, and in diverse ways we have been made to realize it. We are prosperous, yes, but there is an uncanniness about it that bids us take heed. We are progressing, but is the overwhelming tendency in the right direction? We are confident to the point of self-sufficiency, but is it all justifiable? While we have played a part, and a most worthy one up to the present, comparatively our vision, and consequently our activities, have been "cramped, cabined and confined." In a word, we have been poor "mixers." A new era in every phase of our national life has already been ushered in as a result of this world-war and, as a consequence, the trend of our past half century of progress is likely to evidence many offshoots if we would not only maintain our present position, but occupy those others that meantime are offering, and the possession of which will unfold a myriad others.

The omens are in every respect favorable to not only an unbroken continuance of the progress record of advancement of the past fifty years, but to its being stimulated in every sphere of our national life. Whether, in this war-time, we have done all we might or should have done, may be perhaps a moot point, everything considered. We have, however, not done badly, pharisaical even though the statement may seem; but much more is required and, needless to say, it is going to be forthcoming. We have a world-duty to perform, in the doing of which, our native or adopted country, as the case may be, will, as sure as night follows day, be a beneficiary. These are days when liberty—individual and national alike, is being strenuously assailed by tyranny of the foulest dye on the part of a sister nation, and to ensure that the part we have already played in the discomfiture of her tyranny may end in nothing short of her being completely squelched, if for no other reason, although there are others equally good, let the last fit man and the last, however hard-earned dollar, be spent.

CANADIANS should not consider that 1917 will be the only year that rigid economies must be practised. There is no knowing at this date when the war will end, and even after it has ended there will be urgent need for Canada's surplus of food for many months while Europe is being regenerated.

The Operators' Point of View

OVERCOMING TROUBLE WITH STEAM PIPE

By H. Westwood.

IN your May issue J. James made reply to my letter regarding a change he made in steam pipe to his engines. If I understand the section of this journal known as "Operators' Viewpoint," correctly, it is for power plant operators to express their views and for criticisms to be made there, on and not for the purpose of advertising who we are and what we have been. In the first part of his reply he states, "No doubt I am right regarding certain conditions." Just so, the circumstances I referred to did the trick.

We have a Gebhart steam flow meter that speaks the truth on the flow of steam, air, and gas, and it is not theory but a practical instrument found in most up-to-date power plants, that have not gotten rusty lying in the locker. I have a copy of the letter I sent to the April issue, and it did not state that the receiver was 8 ft. in diameter.

Mr. James could not have analyzed my figures with regard to the amount of steam the receiver would contain, or he would have found thereby that the receiver was 8 ft. long and 24 in. wide. I did not deny that his making this change did not remedy the trouble. What I did say, and still adhere to, is that no more steam flows through the 5 in. pipe since the change was made than there did before. With regards to the balance of his reply, which deals mainly with the equipment of his plant, I might say, if we compare the piping in his plant from a financial or first cost standpoint, I am afraid the latter are buying gold mines in their pipe lines.

HANDY SPRING SAFETY VALVE CHART

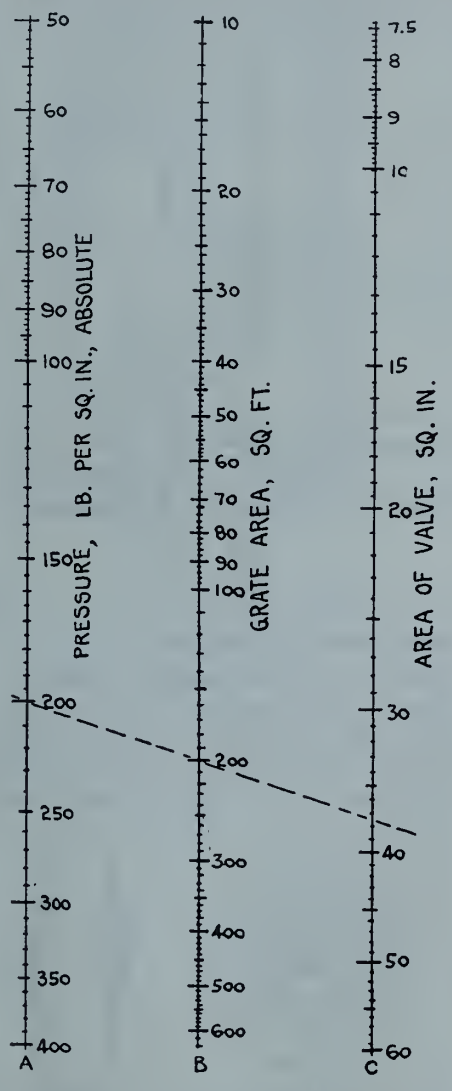
By N. G. Near.

THIS straight line computing chart is based upon the well-known British Board of Trade formula for spring safety valves:

$$A = \frac{37.5\,G}{p}$$

where A=area of valve in sq. in.;
where G=grate area in sq. ft.;
where p=steam pressure in lb. per sq. in. absolute.

As is well known by most marine and locomotive engineers, lever safety valves are impractical on locomotives or on shipboard because of the vibrating or oscillating movement, and for that reason spring loaded valves are used entirely. In marine service two duplicate valves are required by the Board of Trade. The diameter of the valve, also,



HANDY SPRING SAFETY VALVE CHART.

must be 2 inches or more, while the maximum lift of the valve must be at least one-fourth of the diameter. Well, this chart is based on the formula given above. To use the chart simply lay a straight edge across once as indicated by the dotted line and the answer is immediately found in column C.

For example—If the grate area is 200 sq. ft. and the steam pressure is 200 lb. per sq. in. absolute, what must be the area of the valve?

Connect the 200 (column A) with the 200 (column B) and the extension of the line through column C shows the answer to be 37.5 sq. inches. The dotted line drawn across this chart shows how the problem is solved.

Again, the chart may be used "backwards" very nicely for determining grate area or pressure when the valve area is known. Simply swing the straight edge around the area as a pivot and the intersections with columns A and B give the corresponding pressure and grate area for any pivotal position.

The range of the chart, I believe, is wide enough to cover the needs of nearly every marine or locomotive engineer. It includes all pressures from 50 to 400 lbs. per sq. in. and grate areas from 10 to 600 sq. ft.

WHY THE RADIATORS WOULD NOT HEAT

By James Creery.

WHEN the writer took over his present position in a local sanitarium he found that among other things, two radiators on the top floor of one building would not heat. The heating equipment operated on the vacuum system, the vacuum trap operating satisfactorily with a good vacuum. As it was spring time and my time was fully occupied in getting things generally into shape, etc., I put off trying to fix this particular trouble until the summer months and forgot all about it.

When starting up the heat for the following winter, however, I was forcibly reminded of the trouble by the occupants of the room. A good vacuum could be obtained on the return side, so I bypassed the reducing valve and raised the pressure up to about 20 lbs., which heated these two radiators all right, although all the other radiators were hot enough on 1½ lbs. After they were heated I would reduce the pressure again. but was soon called on for more heat. so determined to trace the pipes and found that the troublesome radiators were entirely independent from all the others on that floor. The steam and return lines ran clear through from the basement to the top floor without any branches from either of them.

No provision was made for handling the condensation in the steam pipe which accordingly filled up so that when the weight of water equalled the pressure of the steam no heat could get into the radiators. By inserting a Webster vacuum

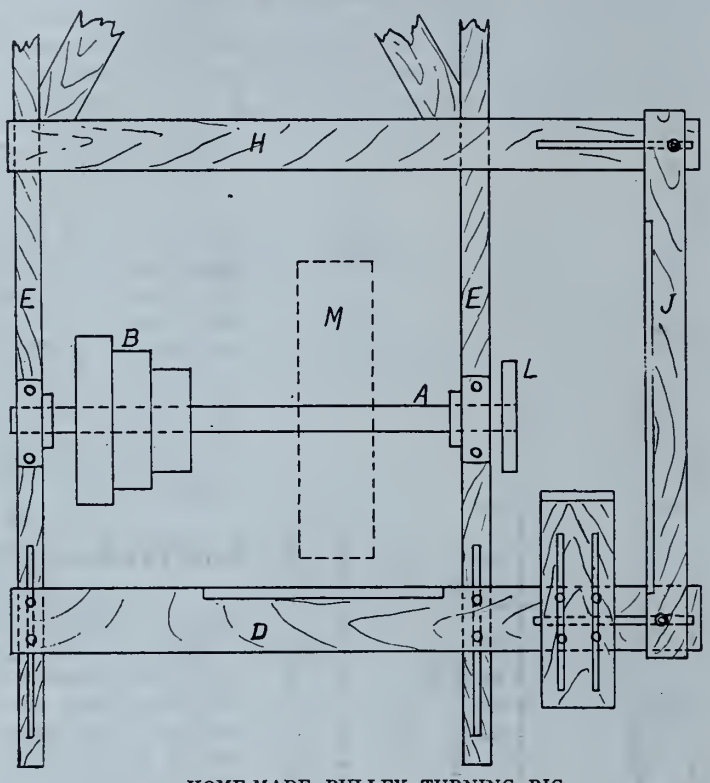
trap at the lowest point of the steam line and joining it to the return line the trouble was overcome, and the two radiators are now heated satisfactorily on 1½ lbs. of steam the same as the others. Moral: There is always a reason for everything.

PULLEY TURNING RIG

By J. E. McCormack.

THE accompanying sketch shows the plan of a rig which I fixed up and used for turning pulleys. The size and proportion of the parts should be governed by the class of work to be done. I use this one for pulleys up to 28 in. dia., with bores of 1½ to 3 in., and used 2 x 4 in. scantling for the pieces EE, and 1 x 4 in. for legs and braces, these parts being made of wood. The arbor used was 1 7/16 in. dia. and 3½ feet long, and is driven by the cone pulley B.

The dotted lines at MM indicate the position of a pulley to be turned. L is a disc or face plate. D and H are supported by the side pieces and in turn support the chisel rests C, K, J. These are adjustable and removable in much the same manner as the long and short rests in wood turning lathes. D is movable to and from the arbor to accommodate different sized pulleys.



HOME-MADE PULLEY TURNING RIG.

The arbor is held from end motion by a collar just inside the frame and against the bearings. One could be put on each side of one bearing if preferred. The bearings are raised so that the center of the arbor is four inches above the upper surface of the pieces EE, thus allowing room for D C J K without raising them too high for convenience. A supply of bushings is kept for use in fitting pulleys of different bores to the 1 7/16 in. arbor.

Very small pulleys are turned on the face plate, being held by a pair of wood screws passing through the disc. The end of the arbor can be fitted with pin or screw as desired, but I did not do so, and, perhaps because of this, I found that in making small pulleys it was better for one not to bore them until after they were turned. After finishing, I make a few circles on the side by using a pointed chisel on the rest J and these serve as a guide for centering exactly when setting up the work, and any slight shifting of the work previous to the lighter finishing cuts does not throw the finished pulley out of true when hung.

FIXING A BALKY VALVE

By J. Haliburton

SOME time ago I was asked to fix a balky hand force pump of the type in which valves are made as in Fig. 1, the same piece of leather serving both as gasket and as valve flap. On one side of the flap there was a brass plate covering most of the said flap and held in place by a screw passing through the leather and screwing into the plate. The head of this screw was broad, yet thin, and was slotted for a screwdriver. Of the three of these valves in the pump not one of them seated properly, because the leather had acquired a "set" in a shape that kept the flap sticking up, as shown in Fig. 2.

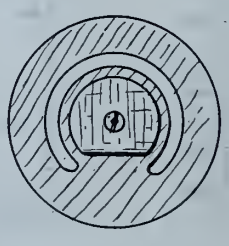


FIG. 1.

FIG. 2.

OVERCOMING TROUBLE WITH HAND FORCE PUMP VALVE.

By removing the leathers from the pump, taking the screw out, and putting the plate and screw each on the opposite side of the leather from what they had been before, and then putting the leathers back into the pump other side up from what they formerly were, I secured the aid of this "set" in the leather to help hold the valve to its seat. After treating each valve in this manner, and priming the pump, it held water O.K., and worked satisfactorily right along although the less drastic remedies previously applied had proved unsuccessful.

REMOVING BROKEN SET SCREWS

By D. A. Hampson

THE quickest removal of a broken set screw ever witnessed by the writer was accomplished by a special tool made from an overgrown three-cornered file. About two-fifths the length of the body of the file had been broken off its smaller end, and the newly broken end on the larger piece ground down to a pyramid shape. Most of the tang was also removed. This tool had been made some time before and for this class of work. The other tools used were, a drill, a lever, and a wrench. The diameter of the drill used was possibly half, but not more than that, of the screw to be removed.

A hole was first drilled in the centre of the broken screw, deep enough to give the special tool a chance to work without its point coming in contact with the bottom of the said hole. This special tool was then placed with its sharp end in the hole and the lever placed inside the frame of the machine and across the tang of the tool, then pressure applied to force the tool into the hole. The tool was then turned backwards with a wrench. At first it acted like a countersinking tool, but soon got hold of enough metal to enable it to give the broken screw a turn and the job was soon finished.

On paper the job looks bigger than it really is. A large three-cornered or square can be easily made into one of these tools and if a size strong enough for the work, will last indefinitely. The drill, wrench and lever are invariably on hand in any plant. The depth of the hole required is very much less than where a square tool with parallel edges is used for turning the screw.

These columns have already given us some kinks on which a screw clamp is useful and I believe that in connection with the above scheme a screw clamp could be used sometimes more conveniently than, and instead of, the lever. It would be advisable to select one having a depression in one of its bearing surfaces into which the tang of the tool could bear while in use. With both clamp and lever to hand, the one best adapted to the construction of the affected part and the neighboring members could be used.

LAST RESORT ON A BALKY LUBRICATOR

By J. E. McCormack.

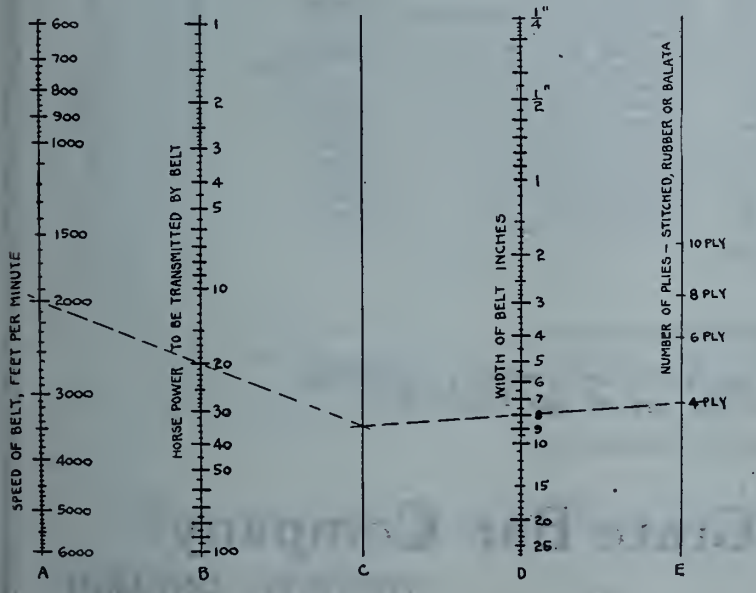
ONE of a pair of engines of which I was once in charge was equipped with a type of single connection lubricator in which the rate of feed was observed by watching the drops of water pass down between a glass disc and a polished brass plate behind it. This lubricator generally gave excellent service, but one day it

was not working so well as usual and the former engineer, now promoted to superintendent, happened along just as I was tinkering with it. When he saw that my efforts had failed, he remarked, "Perhaps it is airbound," and applied a bicycle wrench to the nut connecting the brass arch to the top of the condensing chamber, turned the nut a little to allow leakage, held it there until steam began to come, tightened it again, took a look at the sight feed, and passed on. The lubricator was working nicely. During my stay this lubricator did not balk many times and when it did I always tried the orthodox remedies first. If they did not succeed I then tried this remedy always as a last resort, and so far as I can recollect, it always succeeded probably partly because by the time I got around to the kink no trouble except the air-bind remained. I can not explain the why and wherefore; I only know it produced results. I am inclined to think this trait is peculiar to that particular class of lubricator if not to that individual lubricator itself, but as I consider the remedy simple and not generally known, I pass it on, thinking it may some day help out some one else using a lubricator of similar construction.

HANDY CHART FOR SOLVING FABRIC BELTS IN PLIES

By N. G. Near.

INASMUCH as charts are rare on the subject of power transmitted by fabric belts, the writer has taken it upon himself to produce something that doesn't mention the word "leather" at all. Usually we are told that a 4-ply stitched canvas belt is equivalent to a single leather belt and then we are supposed to know the rest, but we usually have to hunt around in our handbooks for formulae on leather belts, the whole thing is thus highly unsatisfactory. With this chart you simply lay a straight-edge across twice, and the answer is found without difficulty. Knowing any three of the functions—speed, power, width and ply, we can easily determine the missing one.



HORSE-POWER—WIDTH CH ART FOR FABRIC BELTS.

For example, what width of 4-ply Balata belt running at a speed of 2,000 feet per minute is necessary to transmit 20 horsepower?

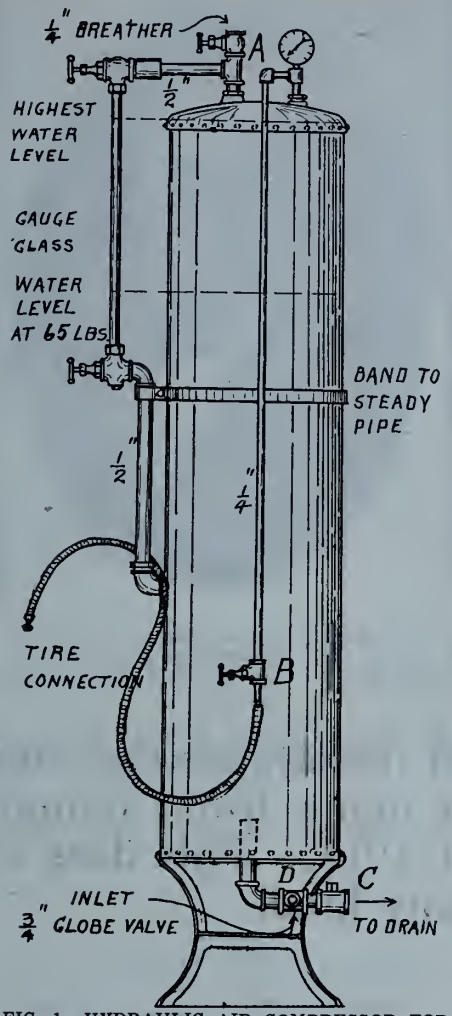


FIG. 1. HYDRAULIC AIR COMPRESSOR FOR TIRE SERVICE, ETC.

Connect the 2,000 (column A) with the 20 (column B), and locate the intersection with column C, then from that point of intersection run over to the 4-ply mark (column E), and the intersection with column D will give the answer as 8 inches.

Again, if we had known the width and wanted to determine the ply, the method would have been about the same. It is so simple that I am sure any reader will understand by merely inspecting the chart.

This chart is applicable to the well known belts made up in plies such as stitched canvas, rubber, and Balata, and the range, it will be noted, is wide enough to care for any ordinary condition.

HYDRAULIC AIR COMPRESSOR FOR TIRE SERVICE, ETC.

By C. Mills

THE accompanying sketches illustrate a simple device to inflate automobile or bicycle tires without the usual manual labor. It is cheaply constructed and very serviceable. The tank is an ordinary 30 gal. water service tank using water at city pressure—60 to 70 lbs.—to displace the air, which is taken away by a small pipe at the top and connected to the tire by a small hose. The tank illustrated in Fig. 1 has been found large enough for tires up to 32 x 3½ in., one filling of water being sufficient for two completely deflated tires or four semi-deflated.

To inflate tire, connect hose coupling to valve stem, close the valves A and C, and open D. The air pressure will rise till it is equal to the water pressure.

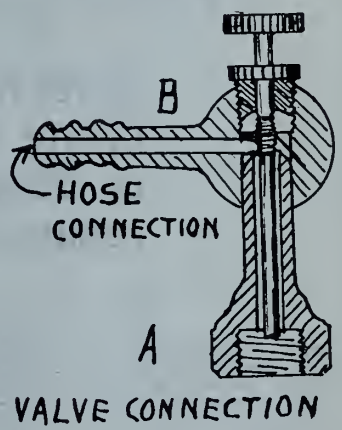


FIG. 2. HYDRAULIC AIR COMPRESSOR FOR TIRE SERVICE, ETC.

When the necessary pressure is acquired, close valve D. Air can be used until the water in gauge glass shows at high level marks, which is about 1 or 1½ in. from top head of tank. Beyond this level, water is liable to get into the air pipe and into the tire. To drain tank, open valves A and C. When empty, it is ready for another charge.

The pressure in the tire will be somewhat less than that in the tank, caused by the tension of the small valve spring in valve stem of tire. If full tank pressure is required, it is necessary to use a small fitting like Fig. 2, which is easily made. It is composed of the usual coupling A soldered into a brass fitting B. A small threaded stem passing down through a stuffing box engages the valve stem, forcing it down from its seat. When inflating tire, turn the small screw two or three turns down after the coupling is connected on valve stem, when tire is full, loosen back the screw before taking off the coupling.

J. J. NEANDER
Eastern Representative

A. H. HETT
General Manager

C. W. ANDREWS
Ontario Representative

A review of installations of 20th Century Grate Bars made from January 1, 1917, to June 30, 1917. This does not include repairs of any kind.

	City	No. of Sets	No. of Sq. Ft.
American Bank Note Co.	Ottawa	1	25½
Booth Co., Ltd., J. R.	Ottawa	6	442¼
British Chemical Co.	Trenton	5	165
Bank of Hamilton	Hamilton	1	18
Collingwood Fruit Farm	Collingwood	1	22½
Canadian Copper Co.	Copper Cliffe	3	24½
City Hotel	London	1	12¼
Cooper Cap Co.	Toronto	2	28
County Orange Hall	Toronto	2	40½
Canada Forge Co.	Welland	2	45
Dineen Co., W. & D.	Toronto	1	10½
Dominion Paint Co.	Windsor	1	15
Dominion Envelope Co.	Toronto	1	20
Eddy Co., Ltd., E. B.	Hull	1	44
Fraser Lumber Co.	Fredericton	3	99
Hyslop & Sons	Greensville	1	18¾
Hamilton Cotton Co.	Hamilton	3	60¾
Harding, Wm.	Toronto	1	10½
House of Refuge	London	2	18
Hazelwood, R.	Clifford	1	18
Hamilton Spectator Bldg.	Hamilton	2	24½
Helena Costume Co.	London	2	66
Johnston & Co., W. R.	Toronto	2	24
Knit-to-Fit Co.	Montreal	1	30
Lufkin Rule Co.	Windsor	1	20¼
Lytle Co., Ltd., T. A.	Toronto	1	33
Moore, J. V.	Toronto	1	7½
McClary Mfg. Co.	London	2	66
McArthur Co., Colin	Montreal	2	55
Ontario Government Institutions..	.....	14	310
Puddy Bros., Ltd.	Toronto	1	18
Pembroke Shook Mills	Pembroke	3	122
Poupore & Co., W. J.	Port Colborne	1	38
Queen's Hotel	Walkerton	1	10
Standard Silver Co.	Toronto	1	8¾
Simcoe Tanning Co.	Simcoe	1	12¼
Toronto Hat Mfg. Co.	Toronto	1	25
Toronto Slipper Co.	Toronto	1	4
Taxicabs Service Co.	Detroit	1	25
Tanner & Gates Bldg.	Toronto	1	12¼
Windsor Hotel	Montreal	1	47
Williams Mfg. Co.	Montreal	1	22
		81	2,118½

Write any of the above users for information regarding the results attained by the use of our Grate Bars.

Boiler Repair & Grate Bar Company

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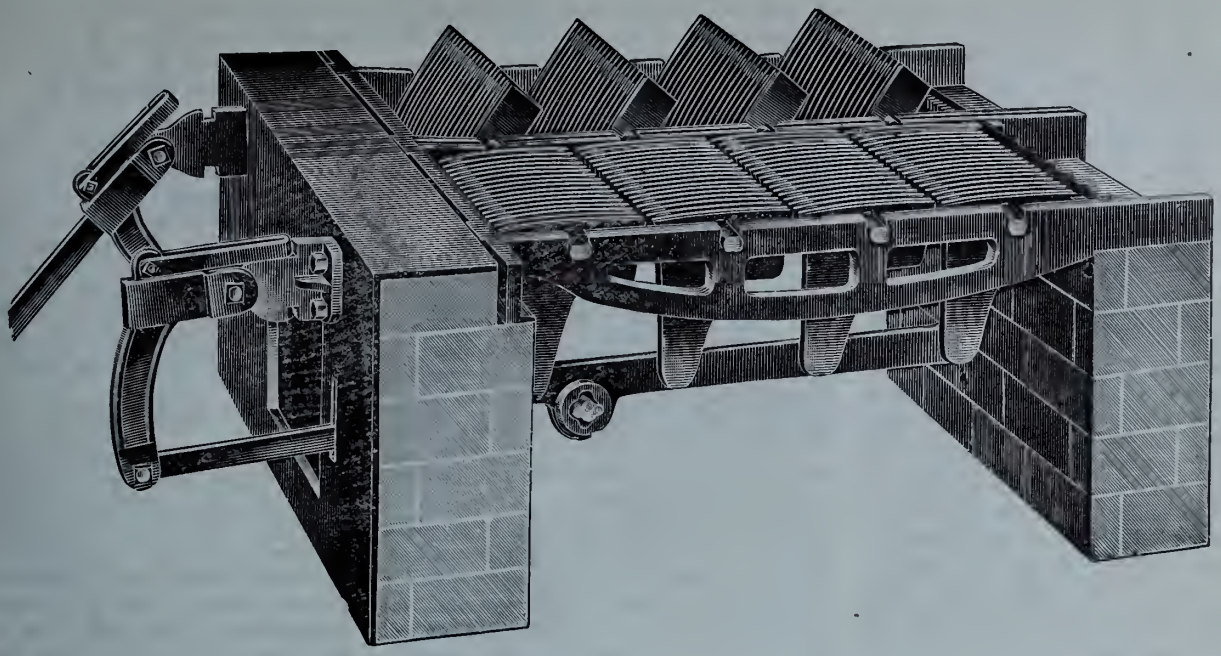

The 20th Century Shaking and Dumping Grate Bar

CHAMPION OF ITS CLASS

WE make the following proposition to all reliable firms in order that you may be convinced of the economical value of our grates:

We will install one set of our Grate Bars of any size, under any kind of a boiler for a trial period of thirty days, and guarantee to make a saving of at least 10% in fuel, and further guarantee the grates to give entire satisfaction in every particular. We leave you to be the judge. If grates are not entirely satisfactory we will remove them and place yours as we found them, without any expense to you whatever.

The best of Steam Specialties of every description carried by us.

Write us about any change you might be thinking about making in your boiler room. We will advise you FREE OF CHARGE.

Boiler Repair & Grate Bar Company

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A SPECIFIC INSTANCE OF SPECIFIC GRAVITY

By J. E. McCormack.

WHEN the writer tells anyone that he has seen solid pieces of iron actually floating on liquid—yes, solid pieces of iron actually floating on liquid" — he takes grave risks of having his word doubted, but the story is really true. Not expecting to see such a thing at the time, he poked with a stick to make sure if what he saw was foreign matter, and floating. He then removed one of the pieces to ascertain its nature, and, upon finding it to be iron, put it back into to liquid again to make sure if it did float, and float it certainly did. A little common sense readily explains the phenomenon, but occasionally a fellow may not happen to be thinking of common sense when first looking at exceptionally uncommon occurrences. We are so accustomed to seeing iron sink that we do not expect solid pieces of it to float of their own accord under any circumstances and this fact might lead some one to sometimes quite innocently make the same experiment that procured for the writer the privilege of seeing iron floating.

The paper frictions of a certain machine needed re-filling and for this purpose were sent to a machine shop in another town. When they were returned one of them was too large to allow its shaft to go down into the bearings properly. Its neighboring friction wheel worked below it and therefore the remedy adopted was to re-babbitt the bearings, but with the shaft lined up an inch or more higher than before, the caps of the bearings being shimmed, or packed up accordingly. As this left a large space to be filled a couple of pieces of old sleigh-shoeing were put in the bottom of each box to help fill up the space and thus save babbitt. The scheme happened to work all right. Probably some of the blocking that supported the shaft was resting on these irons instead of the shaft having been supported by independent blocking placed outside of the bearings.

Some year later, when the frictions had become worn down considerably, the writer undertook to re-babbitt those same bearings, putting the shaft down to near its proper place again. The old babbitt was dug out and melted again for re-use (the shaft being one that ran at only a moderate speed), and as the specific gravity of the babbit was greater than that of iron those long forgotten pieces of old shoeing floated. I wonder by just how much (or little) one or more of them escaped rising up against the shaft while the melted babbitt was flowing around them. If anyone doubt the possibility he is at liberty to drop some spikes or some chunks of iron into a ladle of melted lead or babbitt some time and see for himself if the iron comes to the top or not.

The moral intended is: If anyone has an exceptionally large space to fill with babbitt, don't attempt to fill part of it with old iron without making sure to block it well away from the shaft itself for keeps, whether above or below, lest he afterwards finds that in places he has an iron to iron contact in his newly poured bearing.

Had it not been for the above experience, he would probably even yet have expected that iron placed in the bottom of a space about to be filled with babbitt would remain there even if depending only on its own weight to hold it down. He would probably not have mentally compared the specific gravity of the two metals.

PACKING POINTERS

A BABBITT METAL or brass ring in the bottom of the box of an outside packed plunger is a great aid to packing. It will pay for itself many times over, not only in cost of packing, but also in the general neatness and cleanliness around the pump.

When using packing with high pressure or superheated steam, it is not advisable to use cylinder oil as a regular lubricant. A mixture of cylinder oil and graphite is good, the cylinder oil simply serving to help flow the graphite into position. The graphite gradually fills in the smaller pores of the rod and levels them up, making a smooth surface. The smoother the surface, the less friction there will be between the rod and the packing.

Some engineers make a quick and permanent joint out of a self-vulcanized packing by turning on three or four pounds of steam after the joint is made, and when the joint is thoroughly warmed, dashing a few buckets of water over it, thus cooling the flange and the packing. This causes the packing to harden into position at once. It is a quicker process than that of self-cooling.

Packing if treated right will do a great deal of good honest labor for its master but, if forced, it balks and will not work. A man should be patient with packing, and use it very carefully until it thoroughly conforms to the shape of the box. If it be given plenty of room and well lubricated, it will last for years; but if squeezed into a confined space and run dry, it will soon lose its life.

Stuffing Box Notes

It is a good plan for every engineer to keep a little note book in which to tabulate the diameter or every rod, the diameter and depth of its stuffing box, and the size of the packing required. This enables an order to be made out quickly, and an the same time with certainty. The measurement of a rod in motion, is always guess work. It is also a good plan to number each box that requires packing, and keep extra packings on shelves in the order of the number, so that it can be quickly found in case of emergency.

A good engineer can pack with almost anything. A poor engineer can spoil the best of packing. An engineer, who treats carefully the packing which he puts in and takes care of it as he would a new suit of clothes, will find that it will stand by him and give good service. If he abuse it, however, particularly with the unwise use of a wrench, he will find that it will wear out very quickly. Patience and carefulness are the watchword of success with packing.

Before inserting a packing ring, it should always be dipped in cylinder oil. The advantage thus obtained, far more than compensates for the corrosive effect of the oil. The oil as a lubricant, prevents excessive friction and allows the packing to place itself in position without being burned, and while the oil will affect the rubber, it will not produce as quick and disastrous an effect as the excessive heat would, if no lubricant were used.

Sheet Packing

Some engineers make a practice of placing sheet packing in position on a flange and then cutting the edges with a hammer. This is very poor practice, as it leaves a bruised and ragged edge on the rubber which has a tendency to tear. The best way of cutting is to first mark the outline of the gasket on the sheet and then to cut with a sharp knife. This leaves a clean cut edge and lessens the danger of a blow-out.

When drawing up a gasket, draw the bolts up gradually and on all sides, so that the two flanges approach each other as nearly parallel as possible. If a gasket is drawn up tighter on one side at the start, the gasket is distorted and a probability of blowing out is almost assured. If there are eight bolts in the flange, draw number 1 partly, then skip to number 5, then to number 7, then to number 3, and then to the intermediate bolts. Repeat the same process, drawing them a little tighter. Repeat again setting them up in position.

Starting Up Economisers.—It has recently been pointed out that accidents occasionally occur during the operation of starting up an economiser early in the morning. A careless attendant, for instance on starting will sometimes open to the full the dampers in the economiser chamber, and so allow the whole of the hot flue gas to pass through the chamber, forgetting for the moment that the engines or turbines and the feed pumps have not yet been started up and that there is consequently no water flowing through the economiser. Under these circumstances, the enclosed water becomes heated, until eventually evaporation into steam commences. The level of the water in the vertical pipes then becomes gradually lowered, with the result that the upper portion of the pipes, being bared of water, suffer from more or less overheating. Further, the steam so formed, by coming into contact with the water on the boiler side of the outlet valve, when the latter is opened, tends to cause "water hammer" action. This causes crackling in the pipes, and has in some instances led to fracture and explosion and serious injury to the engineer-in-charge.

Operators' Instruction Course

EDUCATION PAPER—I.

IF THE temperature of steam at 5 lbs. pressure is 227.964 degs. Fahr. and 337.874 degs. at 100 lbs. pressure, how many degrees higher is the steam at the latter pressure?

Subtract temperature at 5 lbs. pressure from that at 100 lbs. pressure; thus, 337.874—227.964=109.910 degrees Fahrenheit.

* * *

The outside diameter of 2½ inch wrot iron pipe is 2.87 inches, and the inside diameter is 2.46 inches; how thick is the pipe metal?

Subtract the inside diameter from the outside diameter and divide your answer by 2; thus, 2.87—2.46÷2=.205 in. metal thickness.

* * *

In a cistern that will hold 326.5 bbls. of water, there are known to be 178.625 bbls.; how many bbls, does it lack of being full?

Subtract the number of bbls. of water known to be in the cistern from the whole content of the latter in bbls.; thus, 326.5—178.625=147.875 bbls. lacking.

* * *

A wrought iron rod is 2.53 inches in diameter; what must be the thickness of metal turned off so that the rod will be 2.495 inches in diameter?

Subtract the rod diameter after turning from its original diameter and divide your answer by 2, thus, 2.53—2.495÷2 = .0175 in. of metal to be turned off.

* * *

The stroke of an engine was found by measurement to be 2.987 feet. How many feet will the cross-head pass over in 600 revolutions?

There are two strokes in each revolution, therefore the stroke in feet multiplied by 2 and by the number of revolutions will give the total crosshead travel in feet; thus, 2.987× 2 ×600=3584.4 feet.

* * *

If a steam pump delivers 2.39 gallons of water per stroke, and makes 51 strokes per minute, how many gallons of water would it pump in 58½ minutes?

Multiply the gallons pumped per stroke by the strokes per minute and by the number of minutes; thus 2.39 × 51 × 58.5 = 7130.565 gallons.

* * *

In a steam engine test of an hour's duration the horse power delivered was found to be as follows, at 10 minute intervals:—25.73, 25.64, 26.13, 24.20, 26.7, 26.34; what was the average horse power?

Add together the horse powers registered at the various intervals, and divide the total by the number of intervals which in this case is six; thus, (25.73 + 25.64 + 26.13 +24.20+26.7 + 26.34)÷ 6 = 25.79 average horse power per hour.

* * *

There are 31.5 gallons of oil in a barrel, how many barrels will there be in 2787.75 gallons.

Divide the total gallons by the number of gallons in one barrel; thus, 2787.75 ÷ 31.5=88.5 barrels.

* * *

A car load of coal, weighing 18.75 tons, costs $60.75, how much is it worth per ton?

Divide the total cost by the total tonnage, thus, 60.75 ÷ 18.75 = $3.24 per ton.

* * *

A keg of 3/16 in. by 1⅝ in. boiler rivets weighs 100 lbs., and contains 595 rivets; what is the weight of one rivet?

Divide the total weight of rivets in the keg by the total number of rivets, thus, 100 ÷ 595 = .168 lbs. weight of each rivet.

* * *

The stroke of an engine is 14 inches; What is the length of the crank in feet, measured from the center of shaft to center of crank-pin?

The distance between shaft and crank pin centres or crank throw is equal to half the engine stroke, therefore, the amount will be 7 inches; but as the answer is required in feet it becomes necessary to divide the crank throw in inches by 12, thus (14 ÷ 2) ÷ 12 = .5833 feet.

* * *

A steam pipe fitted with an expansion joint was found to stretch 1.668 inches when steam was turned into it; state the expansion in decimal parts of a foot?

The answer to this question is found by simply dividing the inches of expansion by 12, there being twelve inches in one foot; thus 1.668 ÷ 12 = .139 feet.

READERS' QUERIES AND ANSWERS

Question.—Give principal dimensions of a 60 inch diameter by 20 ft. long horizontal return tubular boiler?—A.S.

Answer.—In the first place it should be pointed out that horizontal return tubular boilers of 60 inches diameter are never made 20 ft. long. The standard lengths are from 12 ft. to 18 ft. long. The shell thickness varies from 5/16 in. to ½in., depending on the working pressure; the heads are ½ in. thick; the tube diameters may be 3½ ins. or 4 ins., and are in number 71 and 54 for the respective diameters. Basing the heating surface on 12 sq. ft. per horse power, the range is from 900 and 800 sq. ft. for a 60 in. diameter by 12 ft. long boiler, with 3½ in. and 4 in. diameter tubes respectively to 1700 sq. ft. and 1500 sq. ft. for a 60 in. diameter by 18 ft. long boiler for 3½ in. and 4 in. tubes respectively. The horse power range is from 60 to 110 for the various boiler lengths. When manholes are fitted in either or both heads, the number of tubes is reduced, and therefore the heating surface.

* * *

Question.—The plant of which the writer is in charge has at the present time 4 return tubular boilers, each 48 in. x 12 ft., with 52 tubes, 3 in. dia. These boilers are served by a chimney 36 in. dia. x 60 ft. high, induced draft by fan being used. Power requirements demand an additional boiler 60 in. x 16 ft., with probably turbine or motor-driven forced draft fan. The present stack seems to me to be too small to take care of all these units when they are working together in the winter months, but it is desired to avoid the addition of another stack. Do you think that with good forced draft on the new boiler satisfactory service can be had. Souris lignite screenings are used, having a heat value of about 5,500 B.T.U.—the boiler pressure is 100 lbs. The connection from the new boiler would go direct to the chimney and not into the present smoke breeching.—J. R. S.

Answer.—Reliable authorities give the horse-power of a 48 in. x 12 ft. boiler at 50, so that your present chimney is taking care of at least 200 horse-power. The ordinary capacity of a chimney 36 in. dia. x 60 ft. high, is 141 horse-power, with a natural draft, but with induced draft such as you have, 200 horse-power is perfectly feasible. A boiler 60 in. x 16 ft. would rate at 90 to 100 horse-power, so that if the new boiler is to be run at full load right away, the chimney would have an overload of 50 per cent. As far as economy of operation is concerned, the provision of a new stack would be desirable, but if an overload on the induced draft fan can be taken care of, the present stack may quite well do for the present. It would be worth while connecting it to the present stack for a start, as the cost would not be great, and an additional stack could always be installed while it was under operation.

Question.—A gusset stay supporting a surface 13 in. by 13 in. is 10 in. deep by ½ in. thick; the fastening being by means of four ¾ in. bolts; what working pressure is allowable?—A. S.

Answer.—It is clearly evident that the fastening is the weakest feature of the stay; therefore, the combined area of the bolts under the thread must be used in the calculation for working pressure. Assuming the bolt threads to be Whitworth, the area of one bolt at the bottom of the thread is equal to .304 sq. inches; therefore, the combined area of the bolt fastening will be $4 \times .304 = 1.216$ sq. inches. Allowing a safe working stress of, say, 7,000 pounds per sq. inch, we get $7,000 \times 1.216 = 8,512$ pounds. The surface supported is $13 \times 13 = 169$ sq. inches, and this divided into 8,512 pounds, thus $8,512 \div 169 = 50.37$, or the working pressure in pounds per sq. inch that can be carried.

READERS' QUERIES

1—What horse-power is required to operate an air compressor with cylinder 16 in. in diameter by 24 in. stroke, discharging at both ends against a pressure of 90 pounds per sq. inch? A belt flywheel, 12 ft. in diameter, is the driving medium, and the revolutions are 100 per minute.—A. R. P.

* * *

2—What is the refrigerating capacity of a double-acting ammonia compressor whose cylinder is 8 in. in diameter and stroke 16 in. when running at 100 r.p.m.? The piston rod diameter is 2 inches.—A. S.

* * *

3—How many tons of work are performed by an ammonia condenser using 300 Imperial gallons at 60 degs. F., the final temperature of which is 90 degs. F.?—A. S.

* * *

4—How many tons of work result from pumping 160 U. S. gallons of brine per minute through a brine cooler? The temperatures of the ingoing and outgoing brine are 15 degs. F. and 35 degs. F. respectively.—A. S.

* * *

5—The temperature of liquid ammonia is 84 degs. F., and the temperature of brine in the cooler is 2 degs. F. The liquid in order to evaporate must first be cooled from 84 degs. F. to 8 degs F. The cooling takes place right behind the expansion valve, where part of the liquid evaporates and extracts the heat from the remaining liquid. What is the percentage of loss due to cooling the liquid? The latent heat of the liquid at 80 degs. F. is 560.5 B.t.u.—A. S.

* * *

6—A suction pipe, not insulated, passes through a room whose temperature is 60 degs. F. As the pipe must be frosted to deliver saturated gas, a loss is the result. How many B.t.u. are so lost in condensing and freezing one pound of moisture on the pipe?—A. S.

HYDRO-ELECTRIC MEMORANDA

ONE Imperial gallon contains 277 cubic inches of fresh water.

One Imperial gallon contains 10 pounds of fresh water.

One U. S. gallon contains 231 cubic inches of fresh water.

One U. S. gallon contains 8.33 pounds of fresh water.

One cubic foot of fresh water at 62 degrees Fah. weighs 62.55 pounds.

One cubic foot of fresh water at 62 degrees Fah. contains 7.48 U. S. gallons.

One cubic foot of fresh water at 62 degrees Fah. contains 6.23 Imperial gallons.

Water is at its greatest density at 39.2 degrees Fah., at which 1 cubic foot weighs 62,425 pounds.

2.31 feet depth of fresh water at 62 degrees Fah. will produce a pressure of one pound per sq. inch.

Height of column of water divided by 2.31 will give pressure in pounds per sq. inch.

Pressure in pounds per sq. inch due to a column of water multiplied by 2.31 will give the head in feet.

One Imperial gallon of fresh water raised 1 foot high equals 10 foot pounds, therefore 100 Imperial gallons raised 50 feet high equals $10 \times 100 \times 50$, equals 50,000 foot pounds.

One U. S. gallon of fresh water raised 1 foot high equals 8.33 foot pounds; therefore, 100 U. S. gallons raised 50 feet high equals $8.33 \times 100 \times 50$, equals 41,650 foot pounds.

The British thermal unit (B.t.u.) or Joule's equivalent of heat, is 772 foot pounds, and represents the energy necessary to raise one pound of water 1 degree Fah. when at or near its point of greatest density, 39.2 degrees Fah.

One horse-power equals 33,000 foot pounds per minute.

One horse-power divided by $772 = \frac{33,000}{772} = 42.74$ B.t.u. per min.

One horse-power equals 746 watts.

One kilowatt equals 1.34 horse-power.

One kilowatt equals 1,000 watts.

BELT PULLEY NOTES

IN determining what pulleys are best to use in any equipment, the factors of windage, weight, balance, belt contact, powerful compression to avoid keyseating of shaft, and convenience of handling should each have consideration. A choice of pulleys which fulfils these requirements may mean a somewhat high initial outlay, but will mean annually much reduced operating expense.

Pulleys as manufactured are of cast iron, wrought iron, mild steel, wood and iron or steel in combination. For good belt contact, minimum slippage, and least power absorbed without undue recourse to belt dressings to secure adhesion, the wood rim is to be commended. It should, of course, be borne in mind that there are good and bad features in wood pulleys. Belt contact, reduced weight, and facility of handling, are, generally speaking, strong points in their favor, but unless at least the equivalent windage of a well-designed cast iron pulley be had, the other gains may be partly offset. The properly designed wood pulley should be the equal of other types in their best features, and their superior otherwise.

An absence of windage is not always a feature of wood pulleys. The improvement necessary in the reduction or absence of windage in wood pulleys lies in the arm attachment between rim and hub. The arms should be of a shape corresponding to those in cast iron or similar; the material light, rigid, reliable, and attached securely to rim and hub.

The wood pulley has advantage over those of iron or steel, in that it can be run at a much higher speed.

The outer face of a belt travels faster than the inner, causing compression of the latter and extension or stretching of the former. This process has a naturally injurious effect on the substance and life of the belt and should be minimized to the fullest extent possible by using large diameter pulleys, those especially with little crown. Horizontal shaft pulleys should have about ⅛ inch per foot crown, while those on a vertical shaft should have about twice that amount.

Installation of Belting

In applying new belts, care should be taken that the proper side goes next to the pulley. Belts have what is known as a flesh and a hair face; the former of which to the uninitiated might suggest itself as the driving face. This is not so, however, for the reason that the flesh face being tougher, is better able to stand the stretching already referred to, and the hair side which is predisposed to cracking, wears better under compression.

The top end of splices connecting the laps should point in the running direction of the belt. Horizontal belts and angle drives up to 45 degrees from the horizontal plane, should have a sag of about ⅛ inch per foot, and the underside be the driver. Vertical belts should be pulled tight to ensure grip on the lower pulley. Shafting and machinery should be so arranged that belts will run from the former to the latter in opposite directions to equalize the strain and pull on the bearings. Increase of belt width should mean a corresponding increase in thickness, and it is probably true that a thick and narrow belt is more durable and works rather more satisfactorily than does one wide and thin.

Flapping of belts is due to a variety of causes, to which the following are the chief contributors; the ends of the belt at the joint not being perfectly square, pulleys out of line and set at an excessive distance between centres, high velocity running which tends to trapping of the air between belt and pulley, thereby diminishing the adhesive contact. Sudden and often occurring change of speed due to heavy intermittent machine load, invariably causes flapping of belt. Trapping of the air may be counteracted by perforating the pulley rim or the belt.

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The requirements for strainers are so wide and varied that no one type will meet all conditions, but from the many types of Twin Strainers, some one type can be selected that is particularly suited for any condition.

The main principle of all types of Twin Strainers is the Twin (two-in-one) feature. This feature means that when one side of the strainer is being cleaned, the other side is ready to take its place. Just move two valves—and the clean strainer replaces the dirty one—dirty because it's been doing its duty, collecting solid matter from the liquid passing through the strainer.

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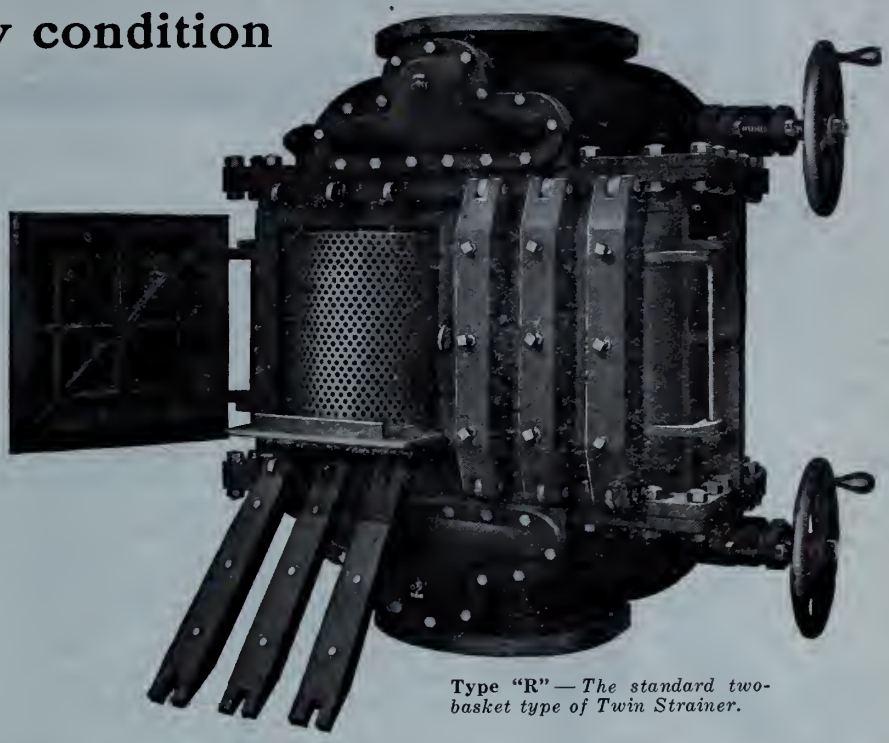

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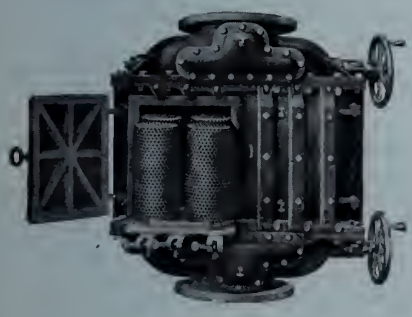
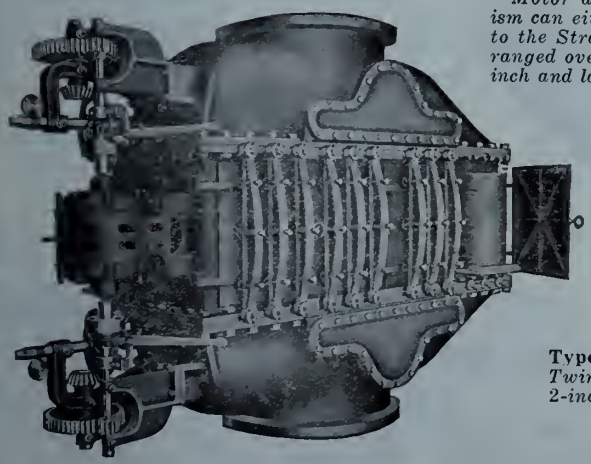


Type "S"—*(on the left) Suitable for use where the liquid to be strained contains large quantities of solid matter, or where it is desirable to use baskets with fine perforations.*

Type "T"—*(on the right) A special type of Twin Strainer for* 150-*lb. working pressure*—16, 20 *and* 24-*inch sizes.*



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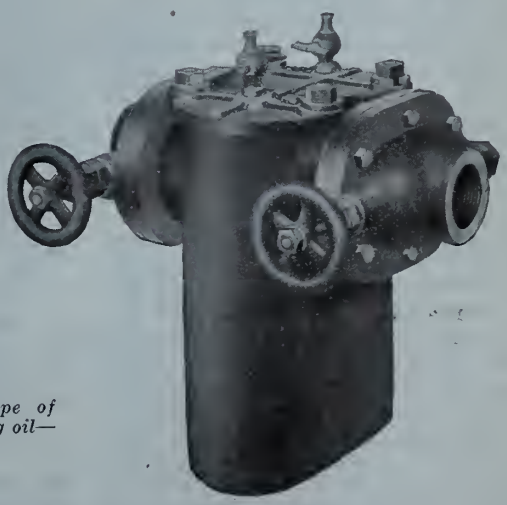


Type "U" — *A special type of Twin Strainer for straining oil*— 2-*inch and smaller sizes.*

Steam Power Plant Auxiliaries

BOILER FEED REGULATORS—II.

THE flexibility possessed by some types of boiler together with the occasional desirability of reducing the water level in proportion to the load carried suggested the idea of producing a device which would enable such operating conditions to be automatically obtained. The development of the idea was

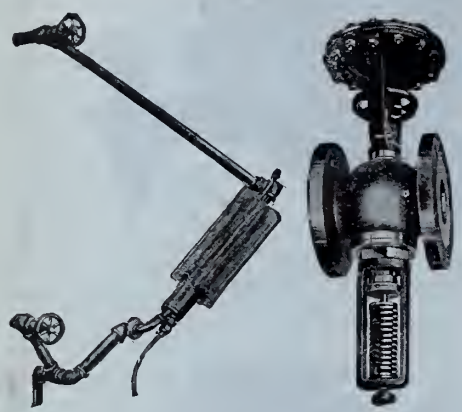


FIG. 3. LEFT, GENERATOR OF "S.-C." REGULATOR. RIGHT, REGULATING VALVE OPERATED BY GENERATOR.

doubtless further prompted by the customary method of locomotive operation, whereby it is usual to raise the water level to the safe high limit before reaching any particular grade. When climbing the grade, the rate of feed is reduced or sometimes discontinued for a short period so that all the heat from the furnace may be spent in making steam and none in heating feed water. The variable type of feed-water heater duplicates in stationary practice that which was found advantageous in locomotive practice, and also provides a uniform rate of feed at any particular level, provided the load is also uniform. In other words the greater the load the lower the level, with correspondingly drier steam and reduced risk of priming.

'S'-C" Regulator

This apparatus possesses as its source of motive power, a certain fixed quantity of water in a closed system, the pressure of the liquid varying with the amount of heat imparted to it through variations of the water level. It is designed to give a continuous graduated feed, increasing as the level decreases, and decreasing as the level rises until at high level it shuts off the feed entirely. Figs. 3 and 4 show the appearance and construction of the device which consists of a generator R, a regulating valve in the feed pipe (not shown), and a hydraulic tube M, connecting the generator with the regulator.

The generator is installed on the same level as normal water level in the boiler and is adjustable to various angles so that the vertical height from top to bottom of generator may vary from 2 in. to 8 in. Through the generator passes a ⅛ in. tube D, which is in series with the steam and water connections, but which does not communicate with the internal space of the generator. The only connection into the generator is the tube M from regulator, and the entire system of generator, tubing and regulator is filled up with water and sealed with plug I. The level of the boiler water in the ⅛ in. tube D will now rise or fall with the boiler. The water in the generator, however, is being cooled all the time by radiation through the extenrnal fins, and kept below boiling point, while a portion of tube D is filled with steam at boiler pressure and tends to heat up the upper part of the water in the generator. According as the boiler level falls, so will more of the tube D heat up the generator and increase the pressure so that the feed pipe regulator will be opened correspondingly more.

The sectional illustration, Fig. 4, shows

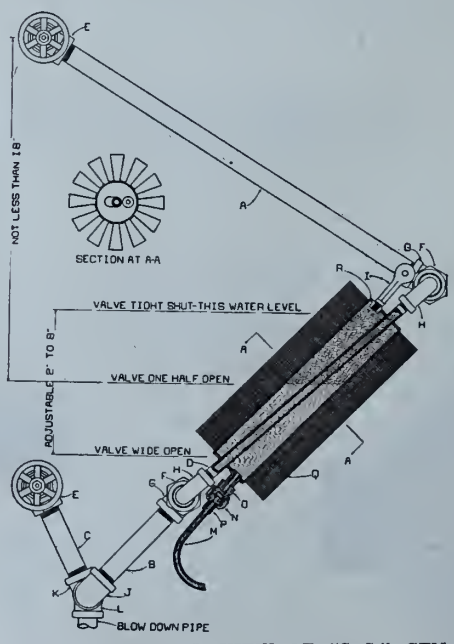


FIG. 4. SECTIONAL VIEW OF "S.-C." GENERATOR SHOWING CONTAINED FLUID UNDER PRESSURE.

the condition of the generator liquid when the boiler level is half way down. The upper portion is changed into steam and maintains a constant pressure in the controlling system; while, if the boiler level rises, the valume of steam decreases with the decreased amount of

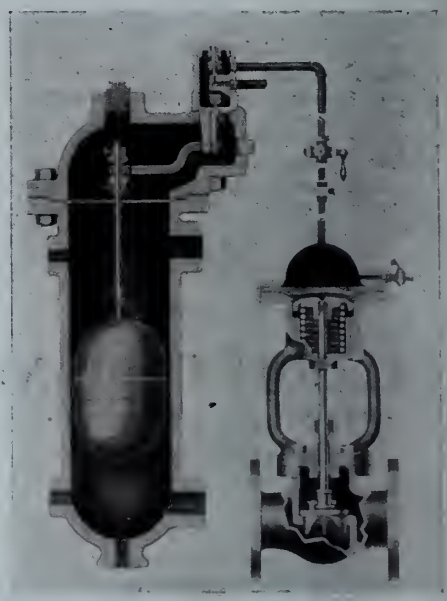


FIG. 5.—SHOWING ARRANGEMENT OF "ELLIOT" FLOAT OPERATED FEED REGULATOR WITH CONTROLLING VALVE.

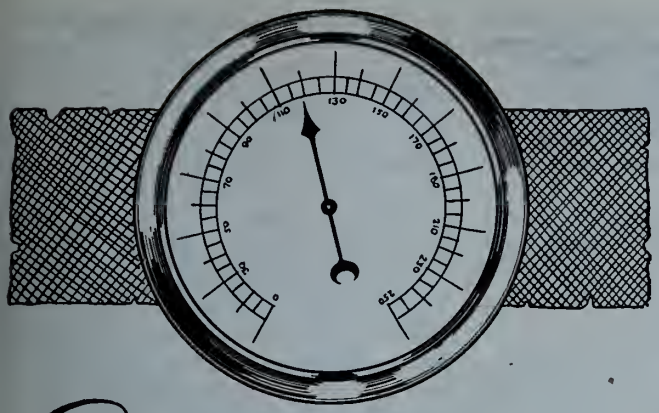
steam in tube D until, at the high limit, the feed is closed off completely.

The flexible fittings used allow of the "S-C" regulator being adjusted when the boiler is in operation, and by varying the vertical height referred to the limits of the boiler level may be set to suit a particular type of boiler. The system so operates that on an increasing load it will always feed at a lower rate than boiler output until peak load level is reached, and on a decreasing load it will feed above the boiler output until light load level is reached. The only time the regulating valve will close is when there is no load.

This apparatus is manufactured by the "S-C" Regulator Co., Fostoria, O.

Elliot Regulator

The objects aimed at by the designers of this regulator are reliability, accessibility, least number of working parts, and ability to make adjustment under full steam pressure. Illustrations Figs. 5 and 6 show one of the designs, which is characterized by the use of a long body water column and a diaphragm type of controlling valve. In actual operation, their relative positions are changed, as the water column is mounted on the boiler, and the controlling valve is located in



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any convenient place in the feed line.

The regulating device consists of a float operated pilot valve, which operates with the fluctuations in the water level and causes the controlling valve to be closed or opened, depending upon whether the water level is above or below

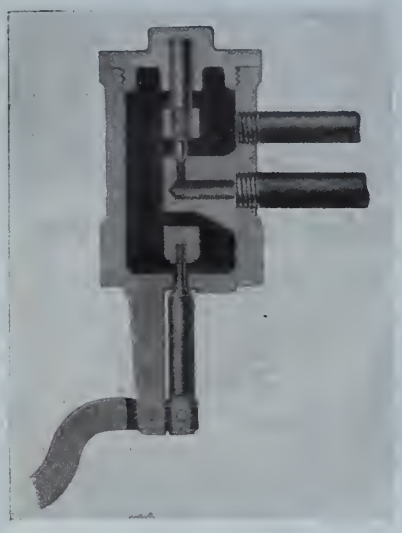

FIG. 6.—ENLARGED VIEW OF PILOT VALVE OF "ELLIOT" REGULATOR

the normal. The pilot valve is shown in detail in Fig. 6, the chamber which contains it being mounted on the top of the water column. An arm extends downward from the chamber and supports the float lever.

The pilot valve is of the double type, the upper valve which controls the exhaust to atmosphere being carried in a yoke, which in turn is mounted on the stem of the lower or steam valve. The exhaust valve is guided on its upper end by a cap which closes the chamber, and which can be removed to enable adjustment of the valve to be made after long service. The upper pipe from the valve chamber, as shown in Fig. 5, is connect- to the diaphragm chamber of the controlling valve.

Assuming the water level in boiler to be above normal, the float rises and lifts up the long arm of the lever, thus opening the steam valve downward and closing the exhaust valve on top. The diaphragm chamber which is filled with water is now under boiler pressure, and the controlling valve spindle is forced down till the valve is closed and the feed stopped. As the water level begins to drop, the weight of the float is gradually transferred to the lever until the weight of the float overcomes the steam pressure which holds the exhaust valve on its seat. When the exhaust valve is unseated, the weight of the float seats the admission valve, and the steam that is contained in the chamber and pipe line passes through the exhaust valve to atmosphere, relieving the pressure and allowing the controlling valve to be opened by the spring provided for that purpose.

As the water level again rises in the boiler, the float has a tendency to rise, but the pressure of the steam on the admission valve keeps it closed until the float has acquired sufficient buoyancy to lift the lever when the cycle of operations is repeated. With ordinary boiler pressures, the necessary buoyancy of the float is obtained with not more than ⅝ in. variation in water level, while the construction of the pilot valve chamber enables adjustment to be made under full steam pressure.

These regulators are made by the Elliott Company, Pittsburgh, the various types being suited for use on water tube and fire-tube boilers of all types.

Foster Regulator

This regulator is of the intermittent type and depends for its action on the alternate expansion and contraction of a length of tube which is filled with steam or water, according to the variation of water level. Its action is slightly different from those regulators which depend on the buoyancy of floats or other bodies, as the time necessary for its coming into action depends on the speed with which the expansion tube radiates its heat. The resulting lapse of time between the change of level and action of the regulator allows it to remain longer in each position with less frequent opening and closing.

As illustrated in Fig. 6 the expansion tube 1 is screwed into the main bracket 2, in which are also fixed two guide rods 4. The upper ends of rods 4 are tied with a bracket 6 on which is hinged a bell crank 8, the short arm of which rests on top of adjusting screw 9 in the upper end of expansion tube. At the lower ends of rods 4 is clamped a bracket 11 which carries bell crank 10, one arm of which is flexibly connected to the long arm of bell crank 8, while the other arm extends horizontally and engages with the stem of the regulating valve 14. Positive closing of this valve is insured by an ad-

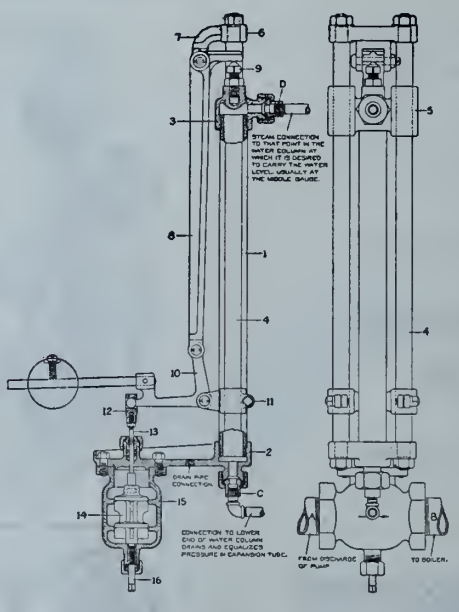

FIG. 7. "FOSTER" REGULATOR WITH EXPANSION TUBE AND MECHANICALLY OPERATED CONTROLLING VALVE.

justable counter weight carried on an extension of the bell crank arm.

The alternate admission of steam and water to the expansion tube is obtained by the method of connecting up the two ends C and D to the boiler. The expansion tube is first of all located at a point completely above the high level of the water in the boiler, after which connection C is carried to a point below the desired level, and connection D to a point just at the desired height of the water level in the column. Whenever the water level falls below connection from D, the expansion tube will be filled with steam, as its lower end is also above water level. The expansion due to the heat of the steam causes adjusting screw 9 to raise the short arm of the upper bell crank, so that the long arm moves over toward the expansion tube and opens up the regulating valve by means of the lower bell crank. The feed gradually attains a maximum as the expansion tube gets hotter, and remains so until the water level rises high enough to close connection from D. Water will now enter both ends of the expansion tube, replacing the steam which condenses as the heat is radiated, and causing tube to contract, so that the feed regulating valve is allowed to close, due to weight of ball on rod, which also causes the short arm of upper bell crank to follow down in top of adjusting screw as the expansion tube contracts.

While a very small variation of water level is sufficient to operate this device, the time necessary for the tube to warm up and cool down, causes less frequency of operation than with certain other intermittent types. There is an entire absence of stuffing boxes, the whole action is mechanical and therefore positive, and the position of the counterweight ball indicates instantly whether the feed valve is open or closed. This regulator is made by the Foster Engineering Co., Newark, N.J.

Economiser Explosions.—The idea that an economiser is safe from explosion because it is only exposed to water pressure is probably due to the fact that vessels which have to be worked under steam or air pressure are invariably tested by means of water. The reason for so doing is that danger is eliminated of the parts flying violently asunder should any part fail, as would happen if steam or air were employed. There is, however, a great difference between an economiser under pressure and a steam boiler or other vessel under cold water pressure. In the latter case, in the event of any part of the structure failing, the pressure is instantly relieved, with very little increase in the volume of the fluid, and no great harm is done; in the former case much of the water in the economiser is usually at a temperature much greater than 212 deg. Fah., so that should the pressure be suddenly relieved due to failure of the containing vessel, a portion of the water would immediately flash into steam, the accompanying violent expansive force of which may cause entire disruption of the economiser.

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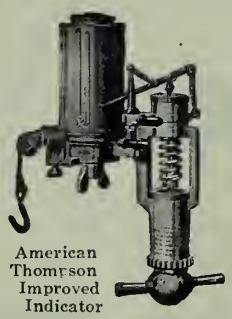

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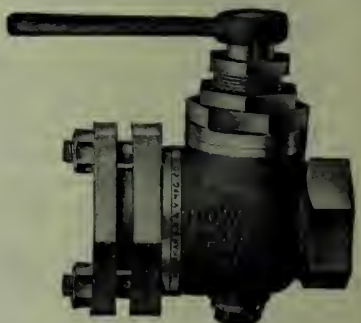

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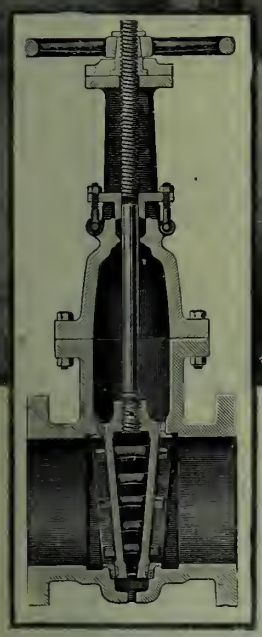

PRATT & CADY Installation in the Fire Pumping Station of N. K. Fairbank, Montreal, Soap Works.

A—shows High Pressure Discharge Valves 12″ constructed for pressure of over 200 lbs. per square inch. B—16″ Low Pressure Suction Intake Valves.

Pratt & Cady valves are popular everywhere because they are easily operated, take pressure from either side and will not wedge. Seat rings are easily renewable without removing the valves from the pipe line.

Made for every service in many patterns and weights. Drop a card for our catalog.

Manufactured by PRATT & CADY Co., Inc., Hartford, Conn.

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The CANADIAN FAIRBANKS-MORSE COMPANY, Limited

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If any advertisement interests you, tear it out now and place with letters to be answered.

When You Buy SKF Ball Bearing Hangers

you also buy satisfaction—the satisfaction of real service.

To know that shutdowns and hot bearings are a thing of the past, to wipe out all transmission troubles at one stroke—that is part of the satisfaction SKF Hangers give.

If you do not know this satisfaction, if you are still using the old type plain bearing, then you should investigate SKF Ball Bearings. Learn how others save time, trouble and money by SKF transmission equipment.

You can learn this, without obligation by sending for our Hanger Bulletin.

CANADIAN SKF COMPANY, LIMITED

47 King Street West, Toronto, Ont.

Sole Canadian Agents for SKF Transmission Bearings:

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SKF

Self-Aligning Ball Bearing Hangers

GRATON & KNIGHT

Standardized Series LEATHER BELTING

Tanned by us for belting use

GRATON AND KNIGHT

Are you trying to drive Pulleys with a Belting Specification?

How often does a belting specification get you the kind of belts you really should have? Do the belts you get agree with the specification? How many men in your plant could tell? Could **you?**

The only specification the belt buyer should attempt to make is a specification of the work to be done. Because to get the work done most efficiently and economically is the only possible reason for any kind of a specification about anything.

Graton & Knight offer you this practical specification—the work to be done. To do the work properly in every case is the basic idea underlying the Graton & Knight Standardized Series Leather Belts.

This Series was evolved to fit the working needs of actual conditions, *not* to meet theoretical conditions as described on paper. Every belt in this Series—and there is one for every transmission purpose—has been standardized only after it has been *proved* right.

Face these facts squarely—then consider the safety, ease and economy of buying Graton & Knight Standardized Belts. Not by guesswork, nor on discount—but on *standardized performance*.

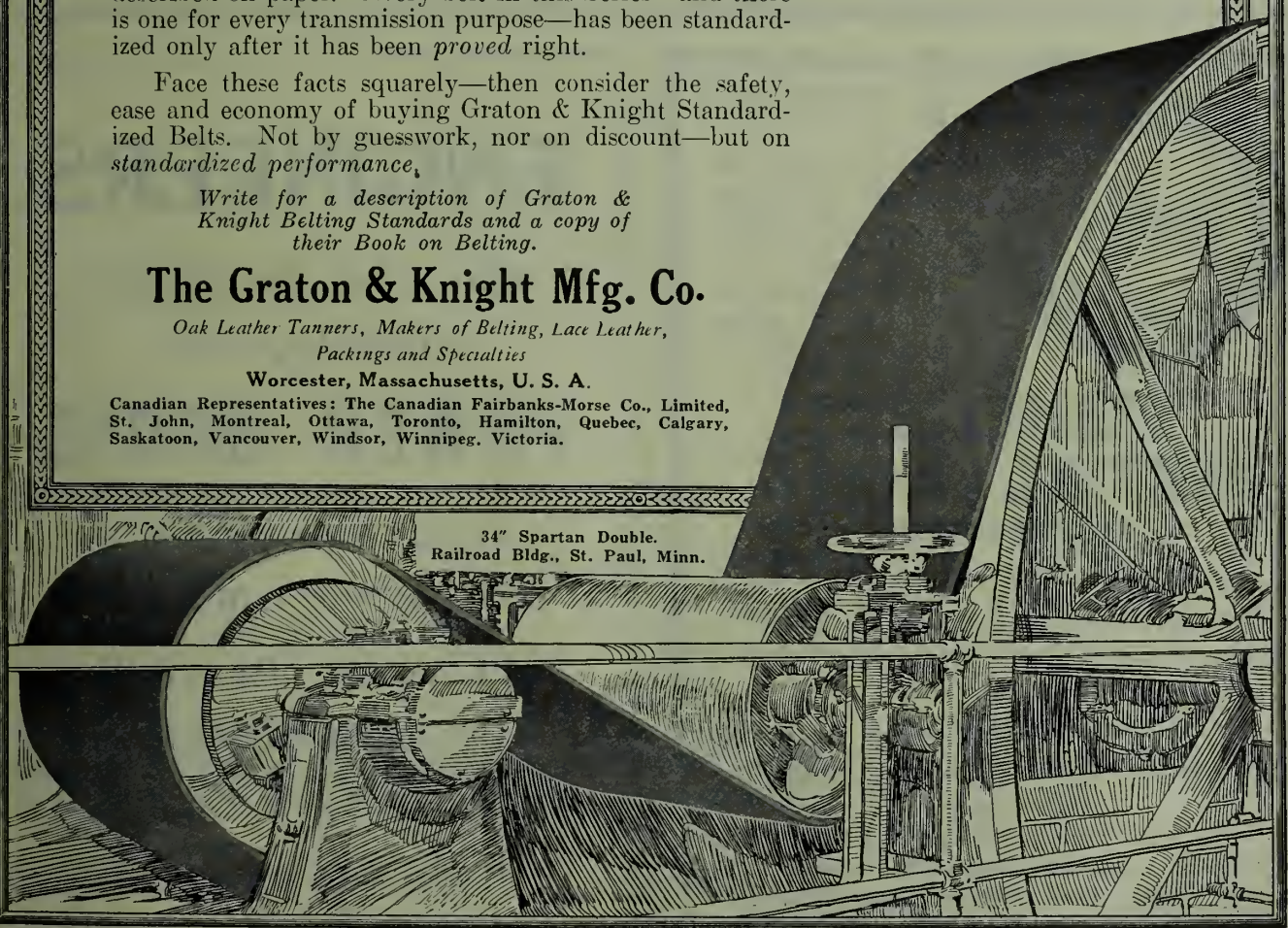
Write for a description of Graton & Knight Belting Standards and a copy of their Book on Belting.

The Graton & Knight Mfg. Co.

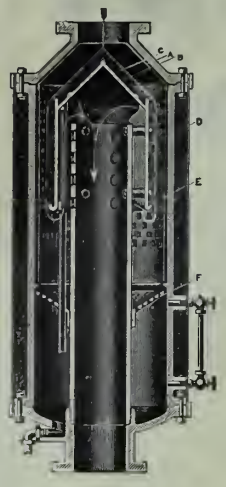
Oak Leather Tanners, Makers of Belting, Lace Leather, Packings and Specialties

Worcester, Massachusetts, U. S. A.

Canadian Representatives: The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Vancouver, Windsor, Winnipeg. Victoria.



34" Spartan Double.
Railroad Bldg., St. Paul, Minn.



VERTICAL STYLE

Sweet's Steam and Oil Separators in all Styles and Sizes.

WATER IN STEAM

With the small clearances now allowed in reciprocating engines, water in steam in small bodies will break either the valve, cylinder head, or piston, or may break all three and cause a general wreck costing hundreds of dollars; in smaller but continuous quantities it will cut out valves, seats and cylinders, necessitating renewals. Water in steam fed to turbines cuts out the blades very rapidly. More cylinder oil is required with wet steam, and there is a constant loss by its use, in efficiency, due to increased initial condensation.

A good separator cures these troubles—a poor one just nibbles at 'em. Let us send our story.

THE DIRECT SEPARATOR CO.

SYRACUSE, NEW YORK

Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

ENGINEERS

who *study* the Advertising Pages of

POWER HOUSE

naturally learn a lot about modern

POWER PLANT EQUIPMENT

which they really ought to know.

TRADE GOSSIP

Princeton, B.C.—The British Columbia Copper Co., will install a power plant and mill shortly.

Prince Rupert, B.C.—It is proposed to establish a new cold storage plant here to aid the fishing industry.

St. John, N.B.—The power house and has awarded the contract for a centrifugal pump to Laurie & Lamb of Montreal.

Estevan, Sask.—The C. P. R. is installing a gas producer plant and a 30-h.p. Canadian Fairbanks-Morse Co.'s gas engine in their pumping station here.

The Turbine Equipment Co., Toronto, have sold to the Midwest Refining Co., two-De Laval combination steam turbine driven boiler feed pumps, suitable for 3000 boiler h.p.

Iroquois Falls, Ont.—The Abitibi Power & Paper Co. have awarded a contract to the Bawden Pump Co., Toronto, for four centrifugal pumps, each of one million gallons daily capacity.

St. John, N.B.—The Power House and laundry will be built in connection with the General Hospital here. Complete equipment is required. F. Neil Brodie of St. John is the architect.

The Storey Pump & Equipment Co., Toronto, have supplied two 3 in. four stage Morris turbine pumps to the Ontario Hydro-Electric Commission for the Chippewa Creek development.

Welland, Ont.—The Electro-Metals Co. have placed an order with the Storey Pump & Equipment Co., for one 8-inch "Morris" turbine pump having a daily capacity of two million gallons.

Hamilton, Ont.—City Engineer E. R. Gray is preparing specifications for the additional steam and electrical equipment which will be installed at the pumping station. The cost is estimated at $127,000.

For Sale

ONE HORIZONTAL RETURN TUBULAR boiler 78" diam. 18' long, good for working steam pressure of 105 lbs.

One new 60" x 14' horizontal return tubular boiler passed and stamped for a working steam pressure of 134 lbs.

One 60" x 16' horizontal return tubular boiler passed and stamped for a working steam pressure of 70 lbs.

One 60" x 14' horizontal return tubular boiler good for a working steam pressure of 90 lbs.

One 35 H.P. locomotive fire box boiler passed and stamped for a working steam pressure of 90 lbs.

All above boilers complete with all usual boiler fittings.

One 15" x 34" Wheelock Engine, right hand.
One 11" x 28" Wheelock Engine, right hand.
One 22" x 48" Wheelock Engine, right hand.
Roofers' tar kettles carried in stock.

LEVY & WESTWOOD MACHINERY CO.,
Toronto.

Port Arthur, Ont.—The Port Arthur Pulp & Paper Co. have awarded a contract to the Storey Pump & Equipment Co., Toronto, for two 10 x 6 x 12-inch "Deane" duplex, end packed plunger boiler feed pumps.

Oshawa, Ont.—The Town Council have given the first and second reading on a by-law to authorize an expenditure of $38,000 on a filtration plant. The John Ver Mehr Co., of Toronto, have already been awarded a provisional contract.

The Bawden Pump Co., Toronto, have been awarded a contract by Fraser's, Ltd., Edmunston, N.B., for 14 centrifugal pumps of from one to four million Imperial gallons daily capacity, and also a compound boiler feed pump. This equipment is for a new pulp and paper mill.

Oshawa, Ont.—The Town Council have awarded a contract to the Turbine Equipment Co., Toronto, for one 6-inch 2 stage, De Laval centrifugal pump, to have 1½ million gals. a day against 340 ft. total head, and to be direct connected to 150 h.p. motor.

The Storey Pump & Equipment Co., Toronto, have recently been awarded the following contracts: Two 4 in. double suction Morris centrifugal pumps for the Swift Canadian Co., Toronto; two 4-stage Morris turbine pumps for Gravenhurst, Ont.; one 4 in., 4-stage Morris turbine pump for the Canadian Copper Co., Sudbury, Ont.

The Turbine Equipment Co., Toronto, have been awarded a contract by the Imperial Oil Co., Ltd., Sarnia, Ont., for two-De Laval 14 in. single stage centrifugal pumps, each having a capacity of 9 million gals. a day against 108 ft., total head. Each of them will be direct connected to Canadian Westinghouse 225 h.p. motors.

Belleville, Ont.—The Town Council have awarded the following contracts to the Turbine Equipment Co. of Toronto. One-De Laval 6 in. 2-stage centrifugal pump, direct connected to a 150 h.p. motor, having a capacity of 225 million gals. a day against 250 ft. total head. Two-De Laval 6 in. 2-stage pumps. One to have a capacity of 1¾ million gals. a day against 250 ft. total head, and to be direct connected to 125 h.p. motor, and the other to have a capacity of 1,100,000 gallons per day, and to be direct-connected to a 100 h.p. motor.

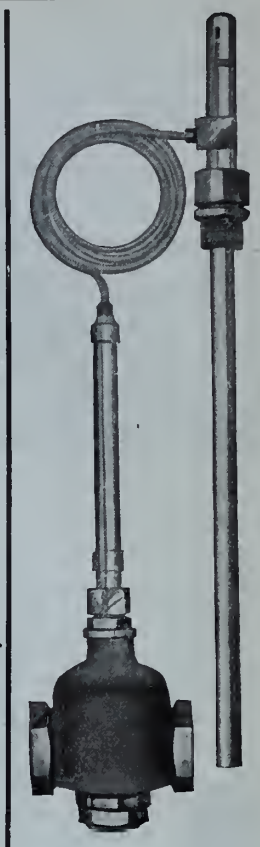
The Galt Foundry Co., Galt, Ont., have recently closed contracts for a large number of their Galt Sprinkler stokers to the order of many prominent concerns, some of which are included among the following. The T. Eaton Co., 3-stokers at Toronto and 12 at Winnipeg; Dryden Pulp & Paper Co., Dryden, Ont. 12 stokers; Hinde & Dauch Paper Co., Tor-

MONCRIEFF'S "UNIFIC"
WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

Too Hot? Too Cold?



Use a Sarco Temperature Regulator and get your conditions right.

If you want to keep your product at any temperature between freezing point and 325° F., you can install a Sarco Regulator and control your heating or cooling medium so as to use just as much or as little as you need. There is no waste and your product will be better and more reliable because produced under standardized conditions.

The Sarco Temperature Regulator is a tube containing oil. When this oil heats it expands; when it cools it contracts. This expansion and contraction becomes effective on a balanced valve which opens and closes, thus feeding or checking the heating or cooling medium so as to keep the temperature where you want it. No hand valve can be operated as sensitively—the SARCO is a thermometer plus a hand. It works twenty-four hours a day, is self-contained and supplies its own motive power.

You can have one on 30 days' trial. Ask for a pamphlet on Sarco Temperature Control and say whether you want to control a water, gas or steam supply.

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Engineers, Manufacturers and Erectors of Steel Structures

We Specialize in
Bridges, Buildings, Towers, Tanks, Penstocks, Roof Trusses, Columns, Smoke Flues and Stacks, Coal Bins, Ore Bins, Buckets, Refuse Burners, Stills, Air Receivers, etc.
WRITE FOR PRICES.

VICTORY
NATIONAL SERVICE
THE RIGHT WORK AT THE RIGHT PAY

After the war—*What?*

Few can predict—yet all can prepare! Our present prosperity rests in part on an artificial basis which peace must remove. Now is the time to consolidate your position by regulating your expenditures—by husbanding the surplus—and by investing to the limit in Canadian War Loans, that help so much to maintain present prosperity.

The National Service Board of Canada

This space is donated by MacKinnon, Holmes & Co., Limited

onto, 8-stokers; Spanish River Pulp & Paper Co., Sturgeon Falls, Ont., 4 stokers; Hamilton Cotton Co. 6 stokers; Dominion Power & Transmission Co., Hamilton, 3 stokers; City of Brandon 2 stokers and Dominion Oilcloth Co., Co., Montreal, 4 stokers.

Montreal, Que.—After a conference with the consulting engineers, Messrs. Vautelet, McRae, & St. Laurent, the Board of Control resolved to instruct the chief engineer to prepare plans showing the modifications required according to the engineers in projects 2, 4 and 5 of the aqueduct. It was further resolved by the board to instruct the chief engineer to prepare specifications for the supply of electricity for pumping purposes. The board also decided to get comparative information on buying electric power for pumping by hydraulic power, with the present project modified, as suggested by the said engineers.

CATALOGUES

Rubber Belting.—Booklet issued by the Goodyear Tire & Rubber Co., Toronto, contains a standard rubber belting price list and a list of firms using this concern's goods.

Air Compressors.—The CanadianIngersoll-Rand Co., Montreal, have issued a new bulletin describing their class FL-1 steam-driven, single stage, straight line, air compressor. The construction and principal features of this machine are described fully, accompanied by detail illustrations and general views.

Pipe Threading Machinery, made by the Landis Machine Co., Waynesboro, Pa., is the title of catalogue No. 23, just off the press. This catalogue illustrates and describes in detail the Landis stationary pipe die head, pipe threading and cutting machines, pipe and nipple threading die heads, pipe and nipple threading machines, and the Landis chaser grinders. The catalogue sets forth the distinctive features of the Landis product, and also contains specifications covering the various types of machinery described. A detailed list of parts is also included.

Air Compressors.—Bulletin K-302, 16 pages 6 x 9 in. illustrating a line of steam driven, straight line, single stage air compressors manufactured by the Canadian Ingersoll-Rand Co., Ltd., of Montreal. The type of machine described is designed to cover the field of those requiring compact, self-contained units of small and medium size for service in shop, foundry, mill or electrical plant, etc. Automatic splash lubrication, dustproof construction, "Circo" silent leaf valves and quick convertibility to melt drive are among the leading features of the design dwelt upon in this publication.

The "F. M. Book".—Even those best acquainted with the Canadian Fairbanks-Morse Company will be surprised at the very wide range of goods shown in their new general catalogue which they have called the "F. M. Book". This book is a marvel of complete mechanical information condensed into a convenient size for easy reference. It contains 1048 pages, and over 4670 illustrations.

It is, in fact, a key or index to the vast warehouses of "Canada's Departmental House for Mechanical Goods" and contains a very wide selection of "Made in Canada" Goods.

Twelve distinct departments are represented, each department covering a line of goods which is ordinarily considered a business in itself.

The scale department (52 pages) covers a full line of Fairbanks Scales.

The valve and steam goods department (138 pages) contains 42 pages of valves, and 96 pages of pipe, fittings, steam specialties and tools.

The automobile accessory department (140 pages)—here you will find every practical accessory for automobile, Ford and otherwise, besides a complete line of motor boat fittings.

Engine department (16 pages) and electrical department (22 pages). These pages are merely an index of the various styles of Fairbanks-Morse oil and gasoline engines, electrical generators and motors. Complete descriptive bulletins of this apparatus will be sent on request.

Pump department (62 pages). Here is shown a very complete line of steam, power and hand pumps, duplex, triplex and centrifugal, besides a number of pump accessories and windmills.

Machine tool department (110 pages). Nearly every type of machine tool is represented; among them some of the best known machine tools on the Continent. Truly a representative department.

Wood working machinery department (88 pages). As fully representative as the machine tools.

Transmission department (86 pages). Every appliance for transmission of power through belts, ropes, chains, conveyors, etc., is here shown.

Railway and contractors department (100 pages). Containing railway track tools, motor cars, road machinery, trucks. etc.. etc. A very interesting section.

Supply department (138 pages). Representing a line of tools and supplies for equipping any factory.

Safe and vault department (26 pages). Showing a line of high grade fireproof safes and vault fronts.

In addition to all this is a 64 page section, printed on yellow paper, and containing beside, an excellent index, a quantity of tabulated information most commonly used.

A copy of the "F. M. Book" will be sent free to any one interested in mechanical lines, on receipt of their request.

Cameron Babbitt Retainer
(Patented in Canada and the U.S.A.)
Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box.
The only satisfactory compound for retaining molten metal and can be used over and over again for months—no deterioration.
For any metal.
For prices and samples apply to
A.S.K. Chemical Company, Elora, Ontario

Where metallic materials have to be cut or united, as in the case of boiler mending, or where broken castings have to be reclaimed, a big saving in time and money, a more efficient job is assured by the use of—

Davis Acetylene Pressure Generators

They represent the most advanced ideas in Oxy-Acetylene Welding, recognized among the world's foremost inventions of this generation. It is revolutionizing the manufactures of metal products, of steel cutting, and the methods of repairing broken and worn metal parts, light or heavy.

We do all kinds of Oxy-Acetylene Welding with the Davis-Bournonville Outfits. Shops where a fair amount of work is done should do their own welding. They will find it most profitable and convenient. We handle Davis-Bournonville outfits and plants, big and small, and give your operator a thorough training course when we make an installation.

Don't lose any time—investigate now. Write for full particulars.

CARTER WELDING CO., LIMITED

9-11 Sheppard Street - - Toronto, Ontario

Canadian Agents for the Davis-Bournonville Apparatus

BOILER ACCESSORIES

By Walter S. Leland, S. B.

Formerly Assistant Professor of Naval Architecture, Mass. Institute of Technology, American Society Naval Architects and Marine Engineers. 144 pp., 72 illus. Cloth binding. A treatise giving complete descriptions of the various accessories of the boiler room and engine room essential to economical operation, such as evaporators, pumps, feed-water heaters, injectors, mechanical stokers, etc., with practical instruction in their use. Price.....Postpaid $1.10

STEAM TURBINES

By Walter S. Leland, S. B.

Assistant Professor of Naval Architecture, Massachusetts Institute of Technology, American Society of Naval Architects and Marine Engineers. 160 pp. 100 illus. Cloth binding. A reliable and up-to-date manual on the selection, construction, and operation of steam turbines, including the installation, performance and types of turbines; single-stage and compound turbines, such as De Laval, Riedler-Stumpf, Rateau, Hamilton-Holswarth, Terry, Parsons, Allis-Chalmers, etc., with a discussion of the use of low-pressure steam turbines with steam engines. Price.....Postpaid $1.10

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Setting the Valves of Canadian Made Engines

We have a limited number of this decidedly useful little book. The information it contains was published as a series of articles in The Power House.

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"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A., PH. D., Superintendent, Trades & Labour Branch.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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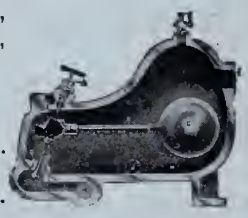

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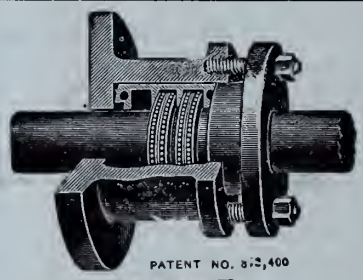
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



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HOLMES' Metallic Packing

is Guaranteed 3 years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

Holmes Metallic Packing Co., Wilkes-Barre, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

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THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa.

Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

WATER SOFTENING OR FILTRATION

FOR BOILER FEED AND ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

High-Class Pumps for Every Service

The Smart-Turner Machine Co., Ltd.

Hamilton, Canada

Keep your service lines free from dirt, grit and all foreign substances—save wear on valves, traps, pumps and other machinery.

THE STRAIGHTWAY SELF-CLEANING STRAINER

will do this and also show a big saving on labor and repair work—easily installed—cleans automatically by opening blow-off. Works in either vertical or horizontal position.

Ask your dealer, or write direct.

SELF-CLEANING STRAINER CO.

6329 Stewart Avenue, Chicago, Ill.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

Consult Power House Buyers' Directory

If what you want isn't advertised in this issue, consult our Buyers' Directory. If it isn't listed in our Directory, write us and we will give you the information.

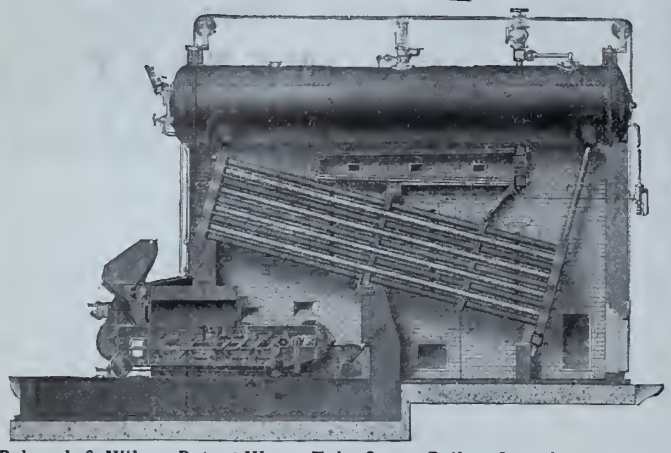
Advertising makes for a better product—

Not only does advertising create a good impression regarding the product advertised but it **makes for a better product.** There are added responsibility and written-printed claims to substantiate.

If any advertisement interests you, tear it out now and place with letters to be answered.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 16,000,000 H.P. IN USE



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

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Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

Our Book "STEAM" sent on request

BABCOCK & WILCOX, Limited

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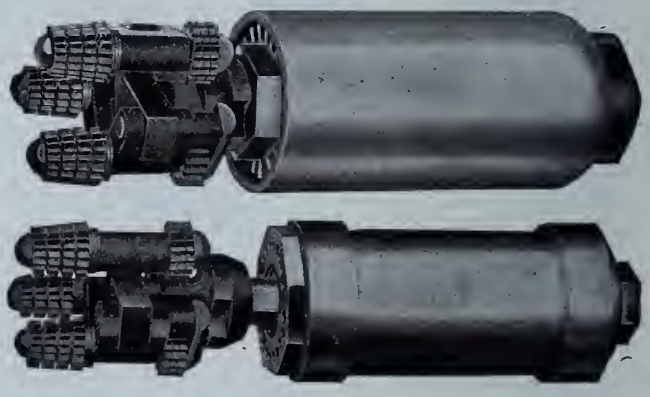
BABCOCK & WILCOX LIMITED

LAGONDA
BOILER TUBE CLEANERS

The latest Lagonda Water and Air-Driven Boiler Tube Cleaners are the most powerful and efficient tube cleaners made. They develop higher speed and greater power than has heretofore been secured with any Turbine Cleaner, and their use will materially shorten the time required in cleaning boilers.

These new Lagonda Cleaners are built for all sizes of tubes, either straight or curved, and they can be driven by water, air or steam.

Ask for Catalog L.



LAGONDA Multiple Water Strainers

The Lagonda Multiple Water Strainer in your water supply main will remove all objectionable solid matter and insure constant and economic conditions of pump and condenser operation. They are easily and quickly cleaned, without interruption of water supply, and take up small floor space. **Ask for Catalog R-2.**

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Branch Office: Traders Bank Building, Toronto

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Garlock Packing Co., Hamilton, Ont.
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Perolin Co. of Canada, Toronto, Ont.

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Bawden Machine Co., Toronto.
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Darling Bros., Montreal.
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Smart-Turner Machine Co., Limited, Hamilton.

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"S-C" Regulator Co., Fostoria, Ohio.

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Peiler, H. L., Montreal.

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Ladd, The Geo. T., Co., Pittsburgh, Pa.
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Jenckes Machine Co., Sherbrooke, Que.
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Waterous Engine Works Co., Brantford, Ont.

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Bovine Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
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Waterous Engine Works Co., Brantford.

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Jeffrey Manufacturing Co., Montreal.
Tod Co., Ltd., G. H., Toronto, Ont.
Victoria Foundry Co., Ottawa, Ont.
Waterous Engine Works Co., Brantford.

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Garlock Packing Co., Hamilton, Ont.

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Mason Regulator Co., Boston, Mass.
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Lunkenheimer Co., Cincinnati, O.
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Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
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Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

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Erica Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

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Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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Boving Hydraulic & Eng. Co., Lindsay, Ont.
Laurie & Lamb, Montreal.
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Goldie & McCulloch Co., Galt.
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Laurie & Lamb, Montreal.
John MacDougall Caledonian Iron Works, Montreal.
Power Plant Equipment Co., Toronto.
Waterous Engine Works Co., Brantford.

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Laurie & Lamb, Montreal.
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Kerr Engine Co., Walkerville.
Waterous Engine Works Co., Brantford.

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Coppus Engr. & Equip. Co., Worcester, Mass.
Green Fuel Economizer Co., New York, N.Y.
B. F. Sturtevant Co., Boston, Mass.

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Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Stewart Heater Co., Buffalo, N.Y.
Waterous Engine Works Co., Brantford.

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Stewart Heater Co., Buffalo, N.Y.

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Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

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Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.

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Canadian Griscom-Russell Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Manufacturing Co., York, Pa.

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Elk Fire Brick Co., Hamilton, Ont.
Gates, John W., St. James St., Montreal.

FIRE CLAY
Elk Fire Brick Co., Hamilton, Ont.

FIRE HOSE
Quaker City Rubber Co., Philadelphia, Pa.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Dart Union Co., Ltd., Toronto, Ont.

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Victoria Foundry Co., Ottawa, Ont.

FLANGED STEAM FITTINGS
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Jefferson Union Co., Lexington, Mass.
Lunkenheimer Co., Cincinnati, O.
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Liberty Mfg. Co., Pittsburg, Pa.
William B. Pierece Co., Buffalo, N.Y.
Roto Co., Hartford, Conn.

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Precision Instrument Co., Detroit, Mich.
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Wm. Hamilton Co., Ltd., Peterboro.
MacKinnon, Holmes & Co., Sherbrooke, Que.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

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Graton & Knight Mfg. Co., Montreal.

FURNACES, BOILER
Gates, J. W., Montreal, P.Q.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.
Tod Co., Ltd., G. H., Toronto, Ont.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Economy Fuse & Mfg. Co. of Canada, Montreal.

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William R. Pierce Co., Buffalo.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

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Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.

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Precision Instrument Co., Detroit, Mich.

GAS PRODUCER PLANTS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
S-C Regulator Co., Fostoria, Ohio.
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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Montreal.
Foxboro Company, Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
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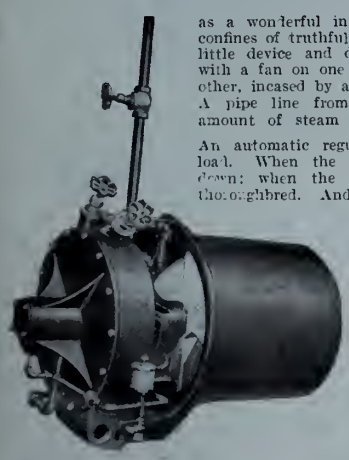

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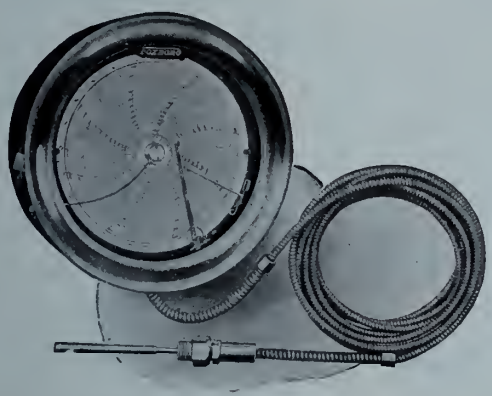

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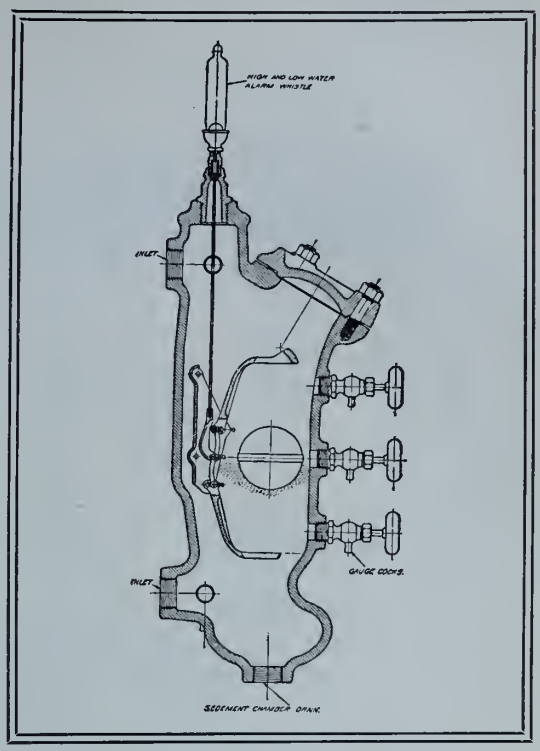

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Jas. Morrison Brass Mfg. Co., Toronto.
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G. M. Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Can. Morehead Mfg. Co., Woodstock.
Nashua Mach. Co., Boston, Mass.
Peiler, H. L., Montreal.
Sarco Co., Inc., New York, N.Y.
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MacLean's for August

An illustration by Ben Ward for "Mam'selle Butterfly" in August MacLean's.

Is a Midsummer Number

AN August magazine will be read by most people when the languor of summer heat possesses them, when entertainment more than heavy stuff is most welcomed. Yet something worth while in the way of special articles is desired—this by the thoughtful few.

The August MACLEAN'S is excellently balanced, as you will see from these contents:

CONTENTS

Frenzied Fiction for the Dog Days—(Done by the Dipperful.) By Stephen Leacock.

The Human Side of Conscription. By H. F. Gadsby.

Winning the War in the Air. By Agnes C. Laut.

A Circus Story. By L. B. Yates.

Mam'selle Butterfly. By Arthur Beverly Baxter.

The Captain of the Susan Drew. By Jack London.

An Andy Doolin Yarn. By Hopkins Moorhouse.

A Detective Story. By Robert E. Pinkerton.

The Gun Brand. By Jas. B. Hendryx.

Women and Their Work—A New Department. Review of Reviews—Regular Department.

Yates who writes the Circus Story, was born in Hamilton. He wrote those stories about Paragon Pete and The Singin' Kid in the Saturday Evening Post.

Leacock is excessively humorous in his Dog Days Sketch, in which he talks about summering and simmering.

Miss Laut fancies that the war may be won by the birdmen, and if Uncle Sam produces 100,000 planes, she may be right.

Gadsby sits in the Press Gallery at Ottawa, and writes brilliantly always. His "Conscription" article is in order.

Pinkerton who writes the detective story, "Old Twilight," knows how to write this class of story.

By the way, Lord Northcliffe has promised an article for the September MACLEAN'S.

You can see that MACLEAN'S for August is just the right type for August.

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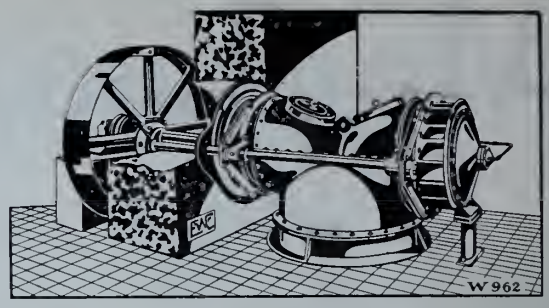

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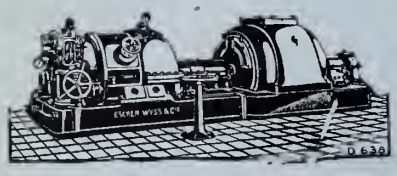

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62-17

INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 36
Alberger Heater Co. 122
American Steam Gauge & Valve Mfg. Co. 120
American Steam Pump Co.... 48
Anderson Co., V. D. 137
Armstrong Cork Insulation Co. 16
A.S.K. Chemical Co. 128
Ault & Wiborg Co. 135

B

Babbitt Steam Specialty Co. .. 36
Babcock & Wilcox 131
Bawden Machine Co., Ltd..... 6
Bennis & Co., Ltd., Ed. 137
Beveridge Paper Co. 40
Boiler Inspection Dept. 131
Boiler Repair & Grate Bar Co. 216, 217
Boving Hydraulic & Eng. Co.. 130
Bowser, S. F., & Co., Inc..... 36

C

Can. Assoc. Stationary Engrs.. 49
Can. Bond Hanger & Coupling Co. 29
Canada Metal Co., Ltd. 1
Can. B. K. Morton Co. 47
Can. Detroit Lub. Co. 117
Can. Fairbanks-Morse Co. 119
Can. Ice Mach. Co. 20
Can. Laco-Philip's Co. 33
Can. H. W. Johns-Manville Co., Ltd. 13
Can. Morehead Mfg. Co. 39
Can. Sirocco Co. 41
Can. SKF Co. 124
Carter Welding Co. 129
Chaplin-Fulton Co. 46
Cling-Surface Co. 29
Coe Co., C. T. 135
Cole, Limited, Geo. W. 10
Coppus Eng. & Equip. Co..... 8

PAGE

D

Darling Bros. 50
Dart Union Co. 11
Davis Regulator Co. 42
Dearborn Chemical Co. 15
D'Este Co., Julian 41
Direct Separator Co. 126
Dixon Crucible Co., Jos. 32
Dominion Belting Co. 23
Dominion Coal Co. 130
Durabla Mfg. Co. 120

E

Economy Fuse & Mfg. Co. of Canada 32
Elk Fire Brick Co. 50
Elliott Co. 115
Escher Wyss & Co. 142

F

Federal Engineering Co. 31
Foxboro Co. 137
Francis, Walter J., & Co. 128
Frick Co. 18

G

Galt Foundry Co. 9
Garlock Packing Co. 35
Garth Co. 130
Gates, John W. 46
Goldie & McCulloch Co. 54
Graton & Knight Mfg. Co. 125
Greene, Tweed & Co. 121

H

Holmes Metallic Packing Co... 130
Hamilton Co., Ltd., Wm. 48
Homestead Valve Mfg. Co. .. 40
Hoyt Metal Co. 30

I

Inglis Co., John ..... Inside back cover

PAGE

International Engineering Wks. 12
Jamison Cold Storage Door Co. 18
Jefferson Union Co. 37
Jeffrey Mfg. Co. 24
Jenckes Machine Co. 4, 5
Jenkins Bros. 43
Jones & Glassco 26
Jones Underfeed Stoker Co., Ltd. 21
Jordan Bros., Inc. 40

K

Kellog & Co., E. H. 32
Kerr Engine Co. 38

L

Ladd, The Geo., Co. 130
Laurie & Lamb 51
Leitch Co., The Arthur S. 42
Levy & Westwood 127
Linde Canadian Refrigeration Works Co. 17
Lunkenheimer Co. 10

M

MacGovern & Co. 34
MacKinnon, Holmes & Co. 128
Magnolia Metal Co. 26
Martell Packings Co. 122
Mason Regulator & Eng. Co., Ltd. 7
McAvity & Sons, T. 42
McDougall Caledonian Iron Works Co. 52
McGhie, W. C. 130
McLaren, D. K., Ltd. 25
Morris Machine Works 50
Morrison Brass Mfg. Co., Jas Outside back cover
Murphy Iron Works 44
Morse Chain Co. 27

N

Nashua Mach. Works 6
National Service Board 128

PAGE

P

Peerless Rubber Co. ..... Inside front cover
Penberthy Injector Co., Ltd... Outside front cover
Pennsylvania Flexible Metallic Tubing Co. 126
Power Plant Equipment Co.... 38
Pierce Co., Wm. B. 45
Pratt & Cady Co. 123
Precision Instrument Co. 135

S

Saddler & Haworth 22
Sarco Co., Inc. 127
"S-C" Regulator Co., The 46
Scaife, Wm. B., & Sons Co.... 131
Schaeffer & Budenberg Mfg. Co. 6
Self-Cleaner Strainer Co. 131
Smart-Turner Mach. Co. 131
Snowdon, C. C. 139
Starrett, L. S., Co. 117
Steel Mill Packing Co. 36
Storcy Pump & Equipment Co. 50
Sturtevant, B. F., Co., of Canada 117

T

Taylor Instrument Co. 16
Thomas Grate Bar Co. 40
Trimont Manufacturing Co..... 34
Toch Bros. 41

U

Uehling Instrument Co. 16

V

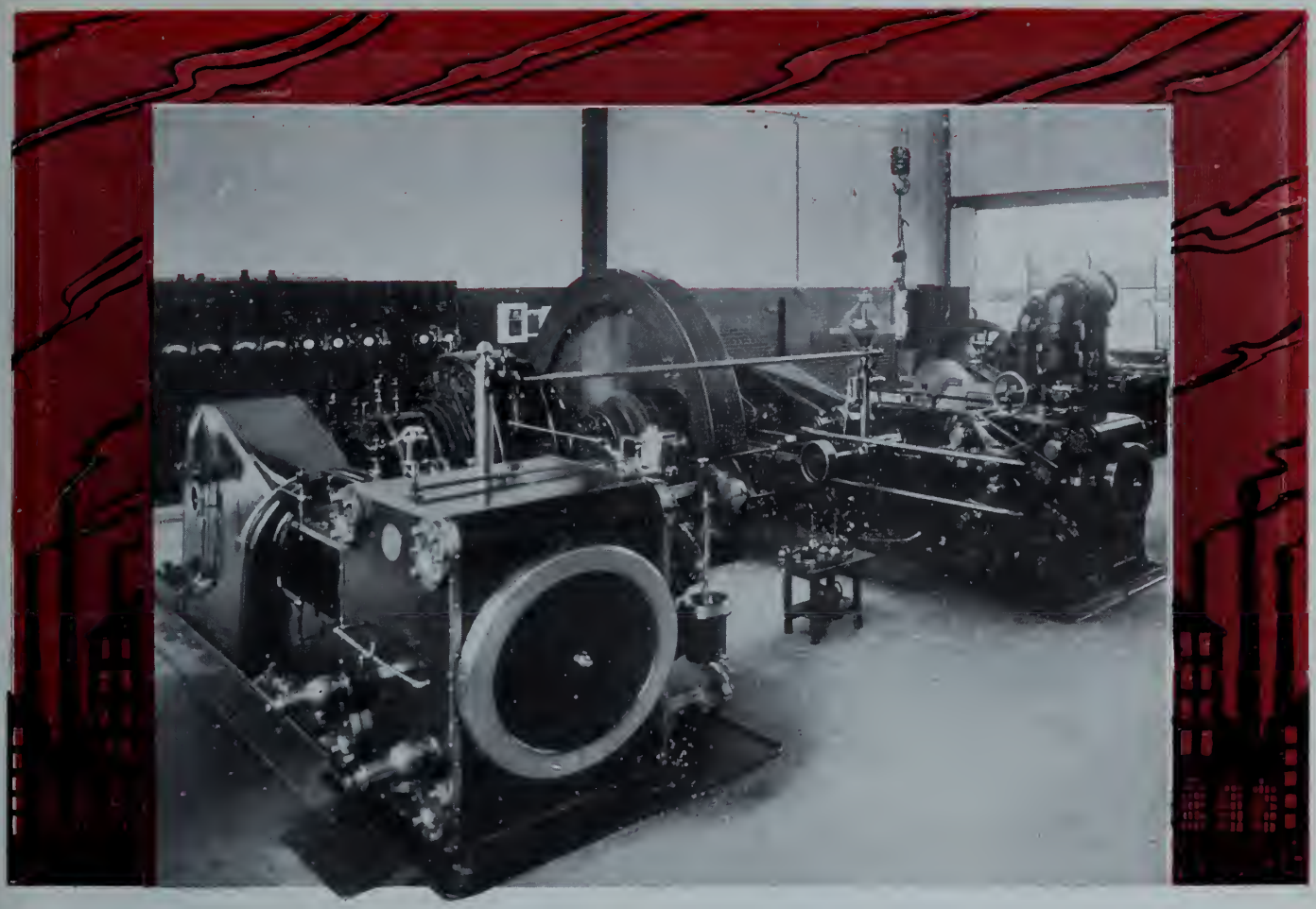
Vilter Mfg. Co. 19
Victoria Foundry Co., Ltd..... 14

W

Wall, W. J. 127
Waterous Engine Works Co...2, 3
Watson & McDaniel Co. 130
Williams & Co., J. H. 34

Y

York Mfg. Co. 20



Another Recent Inglis Installation

Illustration shows our Horizontal Cross Compound Heavy Duty Corliss Engine recently installed in the new plant of the Canadian Kodak Company, Mount Dennis (near Toronto), Ont.

This ideal "Corliss" has cylinders 18 in. and 30 in. by 30 in. stroke, running at 150 r.p.m. It is direct connected to a 300 k.w. Canadian Westinghouse 3-wire, 125-250 volt, d.c. compound wound computing pole type generator.

The Engine operates on a steam pressure of 150 pounds, with 5 pounds back pressure. Valve Gear is operated by double wrist plates set for long range cut-off, the governor controlling both high and low pressure cylinders. Fly wheel is 11 ft. in diameter and weighs 22,000 pounds.

Put your Engine problems in our hands. Firms big and small all through Canada are doing so with the best of results. Tell us of your special requirements and Inglis Experts will go into the details immediately with you.

The John Inglis Company, Limited

ENGINEERS AND BOILERMAKERS

14 Strachan Avenue **TORONTO, Canada**

INGLIS ENGINES

Morrison's Steam Goods and Specialties

A line with a record of big Service

EVERYTHING FOR THE ENGINE AND BOILER ROOM

Morrison's Steam Goods are approved by Provincial and Marine Inspection Departments, and every article is tested before leaving factory.

We'll gladly give you the fullest information on any of the following lines:

Stop Valves, Check Valves, Gate Valves, Safety Valves, Relief Valves, Reducing Valves, Inspirators, Injectors, Ejectors, Jet Pumps, Steam Traps, Water Gauges, Boiler Mountings, Gauge Cocks, Pressure Gauges, Vacuum Gauges, Recording Gauges, Ammonia Gauges, Gauge Boards, Oil Cups, Lubricators, Lumber Measuring Machines, Pipe and Fittings.

Packing Tools and Supplies.

The James Morrison Brass Manufacturing Co.
Limited

89-97 West Adelaide Street

TRADE MARK J.M.T. REGISTERED A GUARANTEE OF QUALITY

Toronto Canada

Largest Brass Manufacturers in Canada

POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Eastern Townships Bank Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1207 Union Trust Bldg.

Vol X—No. 8 Publication Office, Toronto—August 1917 Published Monthly $1.00 per Year.

FILE COPY

TRADE PENBERTHY MARK

AUTOMATIC INJECTORS

"They always work"

For Best Results Use

Penberthy Valves

For Connecting Penberthy Injectors.

It makes the most satisfactory installation.

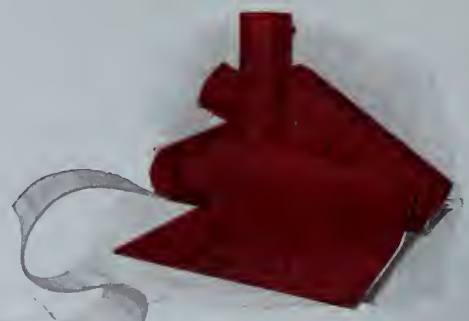
Write for our Valve Catalog.

FILE COPY

PENBERTHY INJECTOR CO., Limited, Valve Manufacturers, Windsor, Ontario

PEERLESS PERFECT PACKINGS

for Every Condition *and* Service



Try it to-day and learn just what Peerless Service means.

A KNOWLEDGE of conditions + combination of good materials = a good packing.

There is no one packing that will cover every condition in your plant any more than one coat will fit every man. For this reason the packing that might work on Jones' engine would not give service on yours although they were exactly the same.

Why?

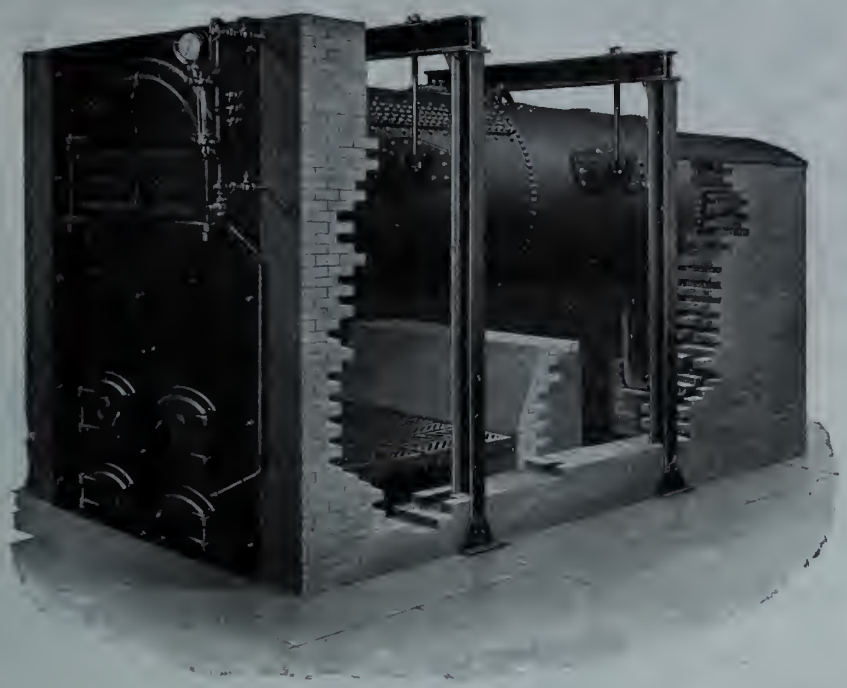
Because the conditions in Jones' plant are different than in your engine-room. You don't care what packing will work in an engine one hundred miles away — you want a packing that will "do the trick" in your plant where you're on the job every day.

That is where Peerless Service comes in — we have over two hundred types and combinations of packings — each one designed to cover certain conditions. All you need do is send full particulars and we'll guarantee to give you service with a Peerless Packing.

Peerless
Rubber Mfg. Co.
31 WARREN ST.
NEW YORK

Sole Canadian Distributors
CANADIAN ASBESTOS Co.
MONTREAL

We Build Complete Power Plant Equipment for Every Installation



WATEROUS RETURN TUBULAR BOILERS

In both Stationary and Portable types, Waterous Return Tubular Boilers are specially suitable for every industrial use. They combine economy in fuel consumption, ease and convenience in operation, with absolute trustworthiness.

"Safety First" is not new as applied to these Boilers—it has been the idea behind every detail of their design and construction for fifty years and more. Exceptional care—exceeding the requirements of ordinary Provincial boiler building regulations—has been consistently exercised in the selection of materials and in every operation of their building.

Let the next boiler you buy be a "WATEROUS."

THE WATEROUS ENGINE WORKS CO., Ltd.
BRANTFORD, CANADA

HIGHEST QUALITY

JENCKES BOILERS

VERTICAL TUBULAR
HOROZONTAL TUBULAR
LOCOMOTIVE TYPES
HEATING BOILERS

Vertical Tubular

Locomotive Heating

For prompt shipment subject to prior sale:

Horizontal Tubular

2—72 x 18, 160 lbs., Ont.
2—72 x 18, 150 lbs., Ont.
1—60 x 16, 135 lbs., Ont.
1—60 x 14, 135 lbs., Ont.

Locomotive Type

2—60 H.P., 125 lbs., Ont.
2—50 H.P., 140 lbs., Ont.
4—50 H.P., 125 lbs., Alta.

Vertical

3—30 H.P., 100 lbs., Ont.
6—25 H.P., 100 lbs., Ont.
9—20 H.P., 100 lbs., Ont.
4—15 H.P., 100 lbs., Ont.

The Jenckes Machine Co. Limited

Sherbrooke
Montreal
St. Catharines
Toronto

Works:
Sherbrooke, Que.
St Catharines, Ont.

Cobalt
S. Porcupine
Nelson
Vancouver

The Metals That Win

"Nickle Genuine" has won the confidence of its users by its uniformity and its efficiency in use. Made for heavy duty machines, motors and dynamos It has established itself as a sure winner. 40 years' experience are manifested in its make-up. It must have merit to be the leader for so long.

"Frost King" Babbitt is indispensable to engines, pumps, rolling mills, pulp machinery or planing mills. It insures the highest efficiency of a machine. There is as much confidence in the users of this "King" of metals as its manufacturers put in it. An inquiry would obtain immediate attention.

Hoyt Metal Company

Eastern Ave. and Lewis St., Toronto, Canada

New York, N.Y. **London, Eng.** **St. Louis, Mo.**

JENKINS·BROS·VALVES·

TRADE JENKINS MARK

Jenkins Bros.

Fig. 106

Fig. 117

Fig. 142

The Valves that stand up under the most trying conditions

fitted with genuine Jenkins' Discs which ensure long and efficient service

When you buy

JENKINS BROS.' VALVES

you can depend upon it that you have the best

The Diamond Trade Mark cast on the body of all genuine valves denotes quality and assures satisfaction. Assorted stocks carried by first-class dealers everywhere.

CATALOGUE No. 8 SENT FREE ON REQUEST.

TRADE JENKINS MARK Jenkins Bros.

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros.

103 ST. REMI ST. · MONTREAL

If any advertisement interests you, tear it out now and place with letters to be answered.

MURPHY STOKERS

as installed in the Power Plant of

CANADIAN KODAK COMPANY, Limited, TORONTO, ONT.

The Canadian Kodak Co. has had 8½ *years' experience* with Murphy Stokers, and the parent Company (Eastman Kodak Co., Kodak Park, Rochester, N.Y), 10½ *years' experience.* The two corporations executed 7 *contracts*—30 stokers, 9,400 H.P.

REPEAT ORDERS; is the best evidence of merit in any device!

For the year 1916 we received REPEAT ORDERS from 63 leading industrial firms and corporations in the United States and Canada, for 154 *Murphy Stokers*—46,623 nominal H.P.; the 63 firms and corporations have executed 299 *contracts* covering 769 *Murphy Stokers*—299,825 H.P.

For January to July 1, 1917—

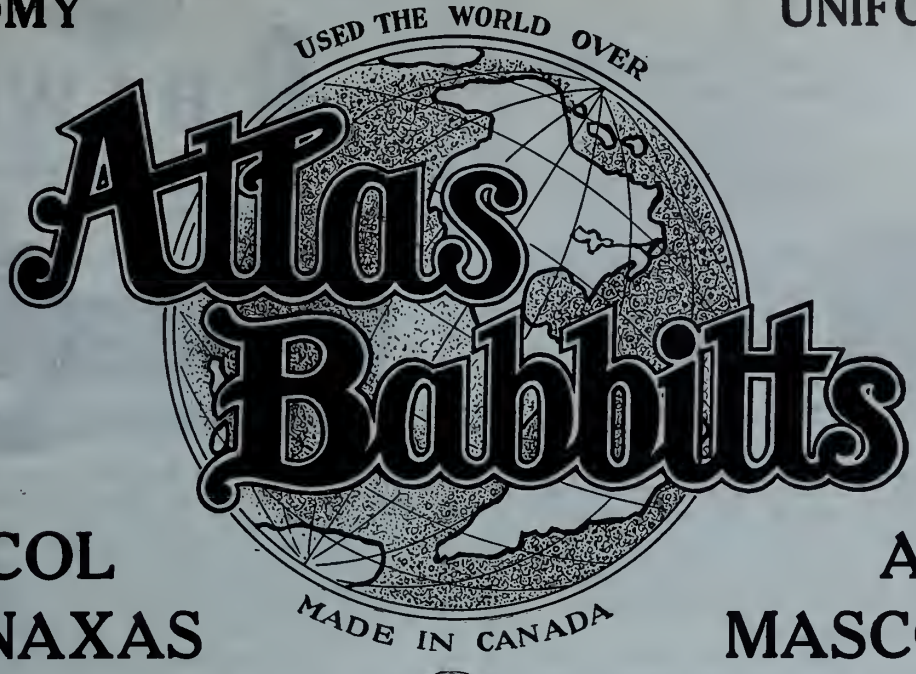
44 *REPEAT ORDERS,* 110 *STOKERS* ..... 35,300 *H.P.*

For catalogue Address

MURPHY IRON WORKS

DETROIT, MICH., or BUFFALO, N.Y.

ECONOMY **UNIFORMITY**



AMACOL **ATLAS**
TENAXAS **MASCOT**
TIN TOUGHENED (M B·K) **W. E. W. BABBITT**

HAVE A WORLD-WIDE REPUTATION FOR UNIFORMITY

ATLAS Alloys are scientific products—the result of much patient research and long years of experience. They are manufactured under the most modern scientific conditions, thereby eliminating any element of chance in their composition and ensuring a standard maintenance of quality and uniformity.

ATLAS Brands are not alloys that *sometimes* give *satisfaction.* They are alloys that can be implicitly relied upon *always.* They are alloys with our *prestige* and *reputation* always behind them.

DO not let prejudice stand between *you* and *profit.* You can obtain the *maximum efficiency* from your plant at a *minimum of cost* by using ATLAS BABBITTS.

THERE IS AN ATLAS BRAND TO MEET ANY NEED

NO SHOCK TOO SEVERE NO WEIGHT TOO HEAVY NO SPEED TOO GREAT

Atlas Metal and Alloys Company of Canada, Limited
MONTREAL

Sales Agents:

The Canadian B. K. Morton Co., Limited

MONTREAL
49 Common Street
Phone M. 3206

TORONTO
86 Richmond Street East
Phones M. 1472-1473

If any advertisement interests you, tear it out now and place with letters to be answered.

WHY

worry because you cannot keep up steam pressure

WHEN

it is so easy and cheap to overcome your difficulties by installing a

COPPUS TURBO BLOWER

It means constant steam pressure, regardless of uneven loads, poor draft and poor coal, and it will pay for itself in a short time on account of better combustion. It also will increase your boiler capacity to 200, and even 300%, of its normal rating without injury to the boiler. Cut out this Ad., put your name and address on the margin and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

In boilers equipped with Coppus Turbo Blowers in four years. The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company

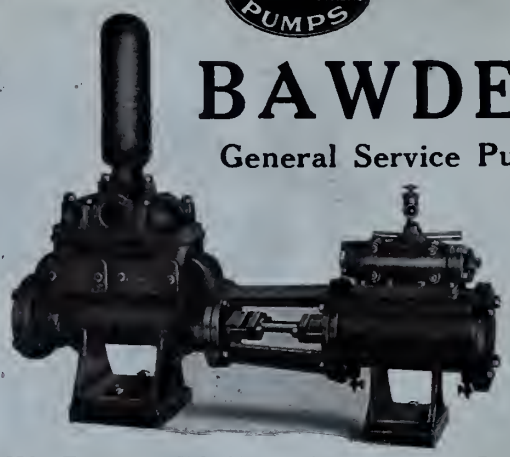
167 Union Street, Worcester, Mass.

Montreal Sales Agents:
H. L. Peiler & Co., Montreal and Toronto.
The Power Plant Equipment Co., Toronto, Ont.

BAWDEN NEVER SHORT STROKE PUMPS

BAWDEN

General Service Pump



NO Tappets. NO External Valve Gear Levers or Springs. NO Internal Tubes or Stuffing Glands.
Construction is of very best throughout.
The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

Drop a card for full particulars.

The Bawden Machine Co., Ltd.

133 Sterling Rd., Toronto, Canada

Agents for Quebec Province:
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
380 St. James Street, Montreal, P.Q.

"Doing Our Bit"

We believe we are "doing our bit" in demonstrating to manufacturers how they can effectively cut down the cost of steam production, better their combustion and increase the capacities of their boilers. In offering the

Coe Turbine Blower

as a wonderful invention, we are well within the confines of truthful advertising. It is such a simple little device and does such a big work! A shaft with a fan on one end and a steam turbine on the other, incased by a shell is about all there is to it. A pipe line from the leader supplies the small amount of steam required.

An automatic regulator adjusts the speed to the load. When the load is light, the blower slows down; when the peak comes it responds like a thoroughbred. And how it does drive the air into the fire! Clinker doesn't get a chance to form.

The gases of combustion which ordinarily pass up the chimney are held back by the draft controller, thoroughly mixed with the air and burned. Nothing gets away that is worth keeping.

Space limits prevent a complete description of the Coe Turbine Blower. Write for it and receive our special demonstration proposition. You should have it. We solicit your inquiry.

C. T. COE COMPANY

Engineers and Combustion Experts

2-14 JOHNSON ST. NEWARK, N.J., U.S.A.

CANADIAN AGENTS:
The Harland Engineering Co., Montreal, Que.

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company

BOSTON, MASS.

IN CANADA
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto

If Quality of Manufacture and Reliability in Service

have any meaning in the Engineering World, this list of our leading specialties should appeal to the best judgment of every Engineer and Power Plant Superintendent.

Mason Standard Bronze Reducing Valve

Mason Reducing Valves (Genuine),
Mason Pump Governors,
Mason Pressure Controllers.

Bundy Steam Traps for every service,
Coppus Turbine-driven Blowers,
Sims Hot Water Generators.

Sims Storage Heaters,
Sims Open Feed Water Heaters.

Bundy Oil Separators,
Ashton Gauges and Safety Valves.

Federal Metallic Packing,
Everlasting Blow-off Valves.

Bawden Pumps (Reciprocating & Centrifugal)
Stratton Steam Separators.

Reilly Multicoil Feed Water Heaters,
Reilly Evaporators and Distillers,
Reilly Multiscreen Feed Water Filters.

New Bundy Return Trap

Mason No. 55 Pump Pressure Regulator

ABOVE EVERYTHING

our Sales Engineers know the *practical application* of our lines to *actual conditions,* and sell from *knowledge,* not from *catalogs.* We furnish *results,* not merely *machinery.*

Reilly Multicoil Feed Water Heater

THIS MEANS REAL SERVICE

Bulletins and full information gladly furnished.

The Mason Regulator & Engineering Co., Limited

Successors to H. L. PEILIER & COMPANY

MONTREAL, 380 St. James Street — TORONTO, 311 Kent Building

FACTORY, 960 St. Paul Street, Montreal

Our Products Made us Known

Our organization, which is one of the largest of its kind on the continent, has reached its present proportions through the quality of our product and our ability to solve and remedy power plant troubles.

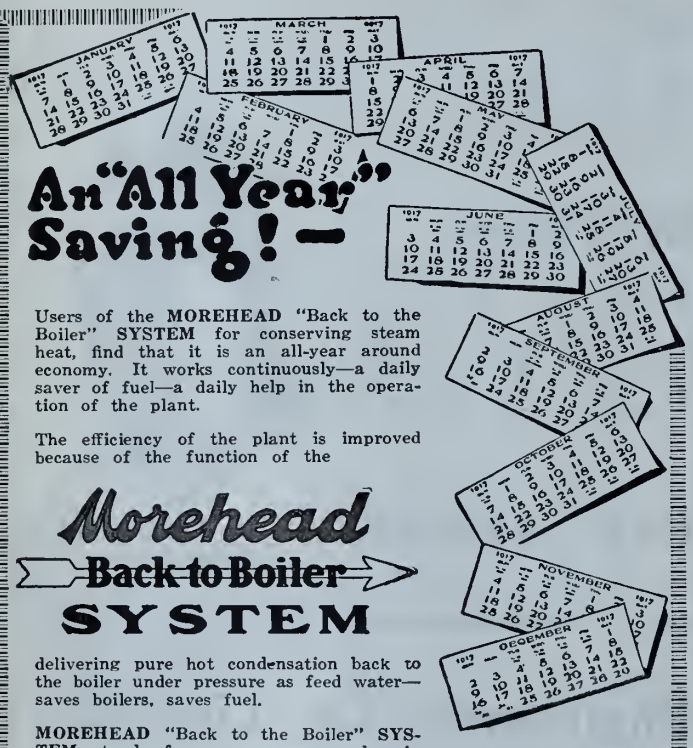
If you have any problems, put them up to Darling Brothers, Limited. Our long experience makes problem-solving easy for us.

We can supply almost everything that is needed in the power plant.

DARLING BROTHERS LIMITED

ENGINEERS AND MANUFACTURERS

MONTREAL TORONTO WINNIPEG VANCOUVER



An "All Year" Saving!—

Users of the **MOREHEAD** "Back to the Boiler" **SYSTEM** for conserving steam heat, find that it is an all-year around economy. It works continuously—a daily saver of fuel—a daily help in the operation of the plant.

The efficiency of the plant is improved because of the function of the

Morehead Back to Boiler SYSTEM

delivering pure hot condensation back to the boiler under pressure as feed water—saves boilers, saves fuel.

MOREHEAD "Back to the Boiler" **SYSTEM** stands for economy—every day in the year.

Canadian Morehead Mfg. Co.

Dept. A
Woodstock, Ontario

420

Paid For Itself in Thirty Days

The chances are that if a device does not prove its worth in thirty days there is little chance that it ever will. But think of this

"Detroit" Systems for Handling Condensation

have records of paying for themselves in thirty days.

Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

In your boiler room, as in many others, there is perhaps adequate provision made to return the condensation.

Better let us send you "Watch Your Condensation."

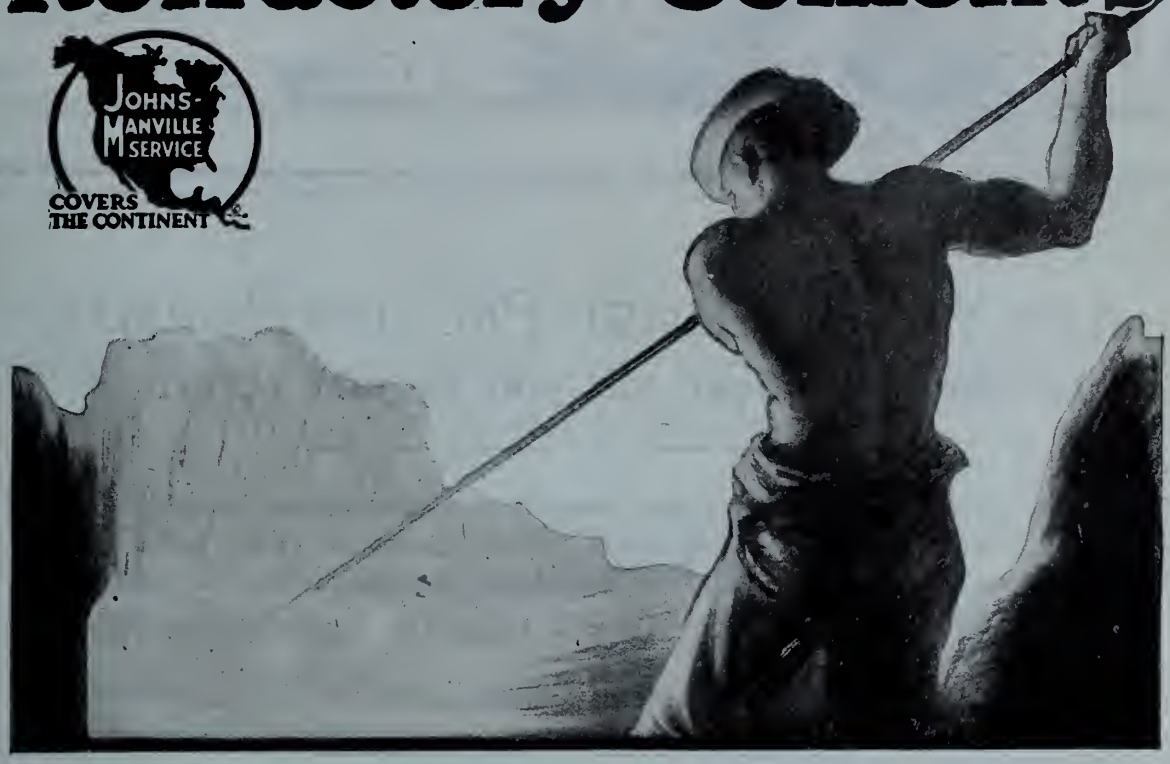
CANADIAN Sirocco COMPANY LIMITED

WINDSOR, ONTARIO.

SALES OFFICES:

Canadian Sirocco Co., 526 Traders Bank Bldg., Toronto. Phone Main 5118.
A. M. Nichol, McGill Bldg., Montreal.
S. S. Clarke, 605 W. Second St., Calgary.
W. W. Hicks, 567 Banning St., Winnipeg.
Canadian Sirocco Co., Ltd., 604 Credit Foncier Bldg., Vancouver.

JOHNS-MANVILLE Refractory Cements



—The Modern Binder for the Modern Boiler Setting

BECAUSE a thing has "always been done that way" is no reason for continuing the old method, especially if it's wasteful and inefficient. Today's work calls for today's methods, today's materials, today's efficiency.

For many years engineers have shut down the boiler every so often to point up or replace the setting—because they relied on fire-clay, and fire-clay failed. The continual expansion and contraction of brick-work squeezed it from the joints, and it cracked and fell out, weakening joints and permitting further destructive inroads of heat. And then came air leaks and lower furnace temperatures or perhaps a fallen arch and the inevitable costly shut-down for repairs.

Today many engineers lay up their boiler settings in Johns-Manville High Temperature Cements — No. 26 or No. 31 for the bond, and No. 32 for surface protection. By taking advantage of materials expressly designed for furnace service they save many a shut-down, for these cements lengthen the life of settings. And each shut-down saved means corresponding savings in labor, materials and heavy overhead charges against idle equipment.

Test them for yourself — set up a portion of your wall with these refractory cements and check up the results. Our nearest branch will supply particulars.

The CANADIAN H.W. JOHNS-MANVILLE CO., Ltd.

MONTREAL TORONTO VANCOUVER WINNIPEG

ARE YOUR SUMMER PROFITS NORMAL

Or does the heat rob you of just returns?

Recent trade developments are forcing manufacturers in all lines to adopt every means to keep their profits normal. You have been investigating, you have studied materials and methods, but—do you

GIVE YOUR TEMPERATURES CAREFUL CONSIDERATION?

Our Engineers have studied these problems 25 years

THE LINDE CANADIAN REFRIGERATION COMPANY, LIMITED

37 ST. PETER STREET, MONTREAL

Manufacturers of Quality Refrigerating Machinery

Vilter Refrigerating and Ice-Making Equipment

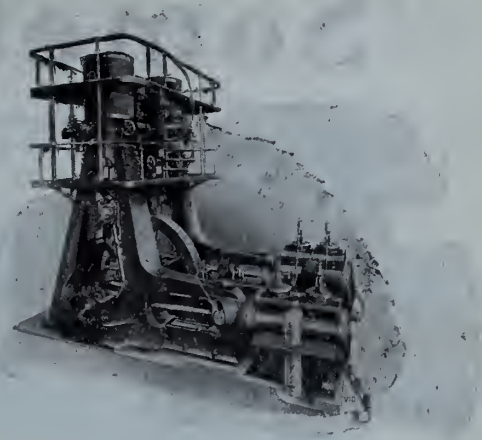
is recognized as standard throughout the world. Our product is built in all sizes and capacities, suitable for every service to which refrigeration is applied. Write us for an estimate covering your requirements.

BULLETINS SENT ON REQUEST

THE VILTER MFG. COMPANY

242 Becher St. Milwaukee, Wis.

DURABILITY



The entire Frick Line of Machinery from the smallest to the largest has been designed with the idea of DURABILITY constantly in mind.

The purchase, therefore, of Frick Equipment is an assurance of long life, small upkeep, and few chances of a breakdown in the midst of the Busy Season.

We are prepared to handle any installation regardless of size or type.

Write or wire us any time and any place.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives: The Frick Ice and Refrigeration Co., Montreal, Canada.

For the Small Plant, Too

Interior of a cold storage room insulated with Nonpareil Corkboard before the Portland cement plaster had been applied. L. A. Mertz Dairy, Rochester, N.Y.

Some owners of small plants conclude that the size of their installation does not warrant the use of the best materials obtainable. But unless they are buying only for the present, with no thought of the future, it is the most expensive course they can pursue.

Whether the plant is small or large, the use of

Nonpareil Corkboard Insulation
FOR ALL COLD STORAGE ROOMS

will prove to be a paying investment. This is being demonstrated every day. Just read what the Sinton Dairy Company, Colorado Springs, Colorado, wrote on April 24, 1916:

"We find the (Nonpareil) cork insulation very efficient. Of course ours is a small plant and we debated the advisability of installing such high-grade insulation; but after a year's use we feel that we have done well to use your cork. It's like buying a good motor truck instead of a cheap one—high cost at first, but cheaper and less grief in the long run."

Detailed information, telling how you can use Nonpareil Corkboard profitably in your plant, will be sent free of charge on request.

Also manufacturers of Nonpareil Cork Covering for cold pipes and tanks; Nonpareil Insulating Brick for boiler settings; Nonpareil High Pressure Covering for steam lines; Nonpareil Cork Machinery Isolation for deadening noise of fans, motors and pumps; and Linotile for floors in offices and residences.

ARMSTRONG CORK & INSULATION CO., LIMITED
504 McGill Building -:- -:- **Montreal, Que.**

If any advertisement interests you, tear it out now and place with letters to be answered.

Something New

In the 4th Edition of our Fittings Catalog, recently issued, we illustrate a line of SCREW AND FLANGED AMMONIA FITTINGS, supplementing the large line of Standard YORK Valves and Fittings which are coming into more general use each year.

This is in line with our policy to design and place on the market Fittings and Apparatus that will make the application of MECHANICAL REFRIGERATION more convenient and economical.

From the number of orders received, it is quite evident that these SCREW AND FLANGED FITTINGS have met with the endorsement of the practical Engineer.

By their use YOU can—

SAVE WEIGHT WITHOUT LOSS OF STRENGTH OR CONVENIENCE.

ELIMINATE *ONE-HALF* THE *GASKET* JOINTS.

DO MORE RAPID PIPE FITTING, by ELIMINATING *ONE-FOURTH* OF *ALL JOINTS.*

as compared with full flanged fittings.

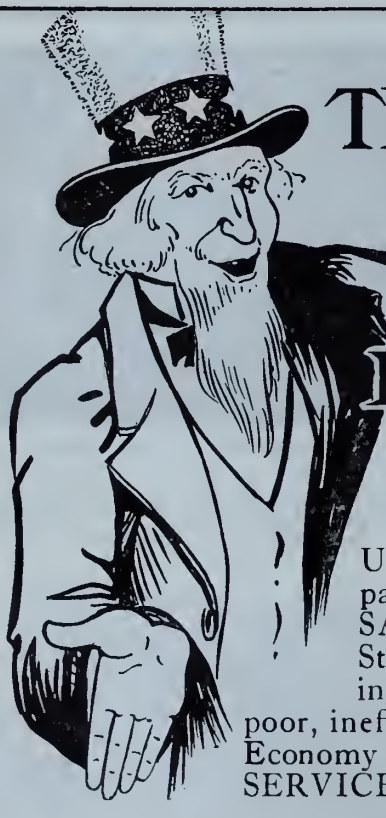
York Manufacturing Co.

(Ice Making and Refrigerating M chinery Exclusively)

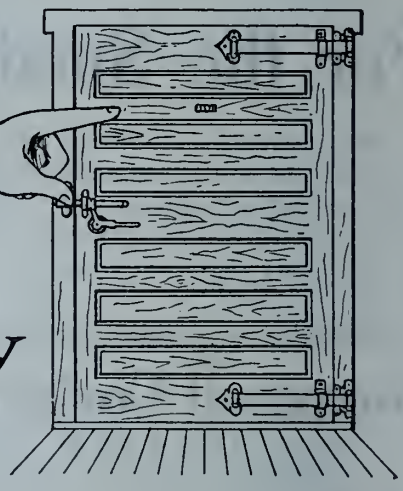
YORK, PA.

Represented in the Dominion by **CANADIAN ICE MACHINE COMPANY**

MONTREAL, 626 Coristine Bldg. TORONTO, 82 Chestnut St. WINNIPEG, 85 Lombard St.



These Doors SERVE Because They SAVE



UNCLE SAM uses them. CANADA uses them. The biggest packers and storage houses use them. BECAUSE THEY SAVE DOLLARS. "JONES" AND "NOEQUAL" Cold Storage and Freezer Doors (standard or fireproof) are rendering a National service because they shut out losses caused by poor, inefficient doors. May we have the pleasure of sending "The Economy of Patented Cold Storage Doors" which describes the SERVICE fully?

Jamison Cold Storage Door Co.

Formerly Jones Cold Storage Door Co. HAGERSTOWN, MD., U.S.A.

BELLISS & MORCOM, LTD.
Engines and Air Compressors

Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: MONTREAL

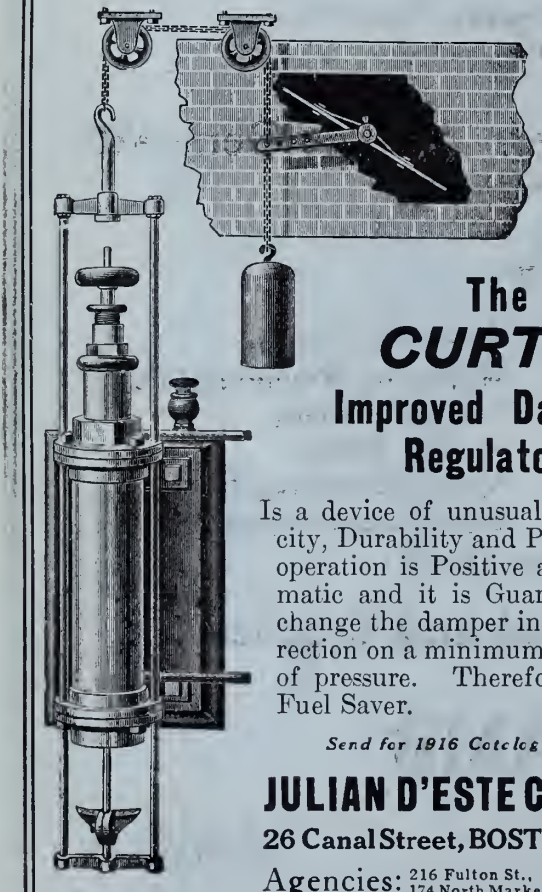
KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**



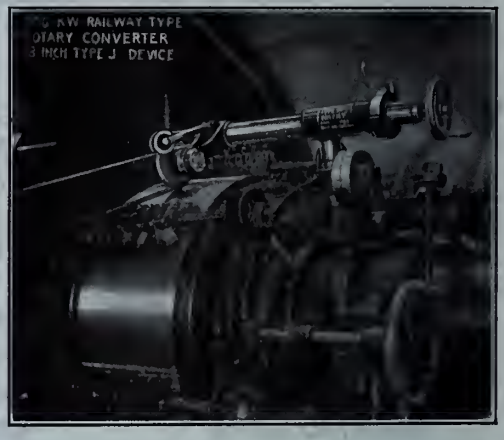
CURTIS
Engineering Specialties

The *CURTIS* Improved Damper Regulator

Is a device of unusual Simplicity, Durability and Power. Its operation is Positive and Automatic and it is Guaranteed to change the damper in either direction on a minimum variation of pressure. Therefore it is a Fuel Saver.

Send for 1916 Catalogue.

JULIAN D'ESTE COMPANY
26 Canal Street, BOSTON, MASS.
Agencies: 216 Fulton St., New York City
174 North Market St., Chicago, Ill



COMMUTATOR TRUING DEVICE

Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

Jordan Bros., Inc.
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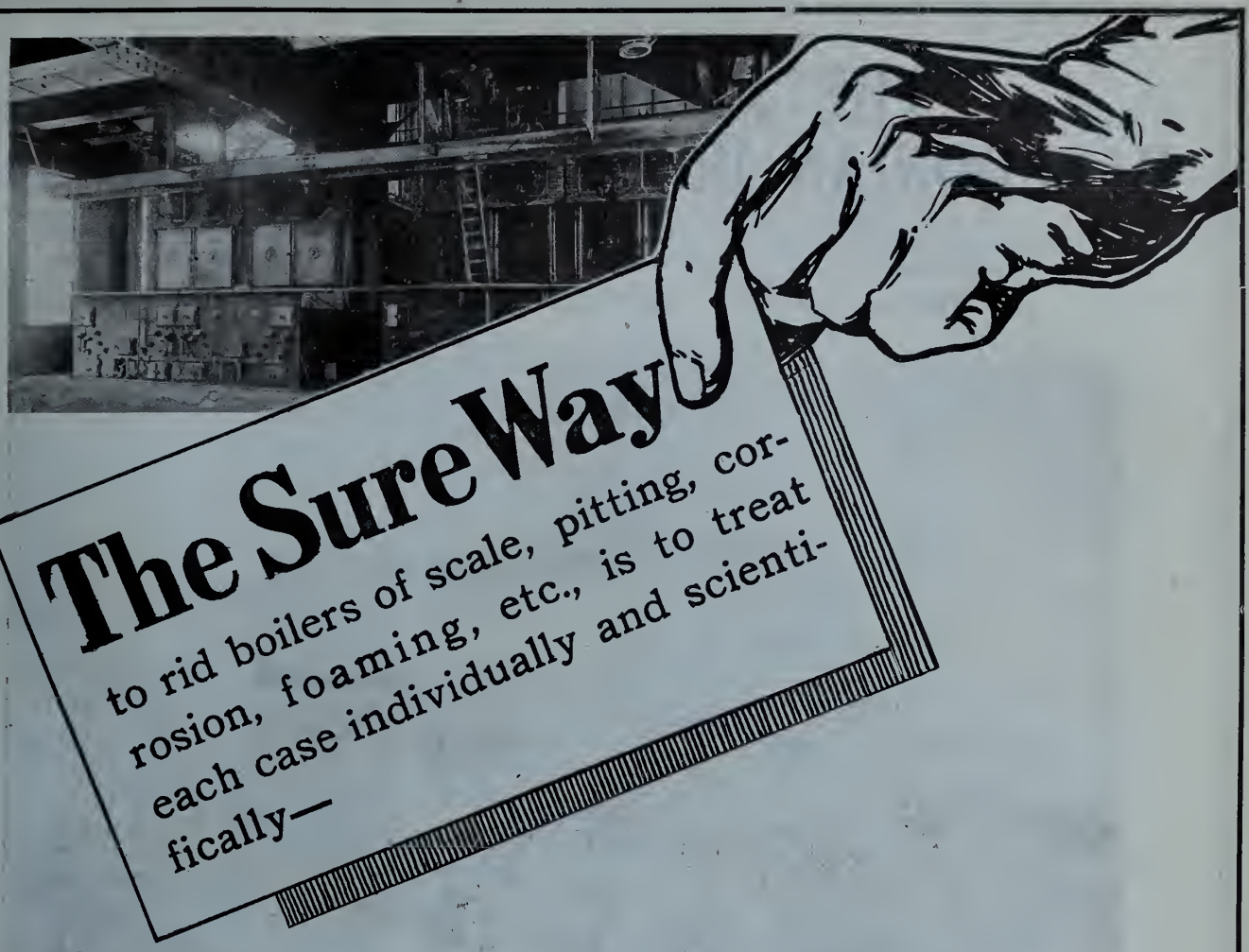
Canadian Representative :
CANADA SALES CO., 183 Church Street, Toronto, Canada



The Sure Way

to rid boilers of scale, pitting, corrosion, foaming, etc., is to treat each case individually and scientifically—

That's the "Dearborn" Way

Dearborn Feed Water Treatment is scientifically prepared (after analysis of feed water) to meet the requirements of the mineral ingredients and other objectionable constituents of the water, the percentage of each mineral salt governing the percentage of the antidotal ingredient in the treatment. By these methods we avoid the use of an excess or deficiency of any part of the treatment, every pound being utilized in the reactions taking place. There is no mechanical, unknown or unlooked for result obtained from the use of our goods; we cause a complete chemical reaction to take place between the deleterious constituents of the water and the ingredients of our preparations.

Send us a gallon of your feed water — we will analyze it and tell you what the Dearborn Treatment can do and what the cost will be.

IT'S ONLY BUSINESS for you to investigate any proposition which promises big economies and big gains in operating efficiency.

DEARBORN CHEMICAL COMPANY, of CANADA, LIMITED

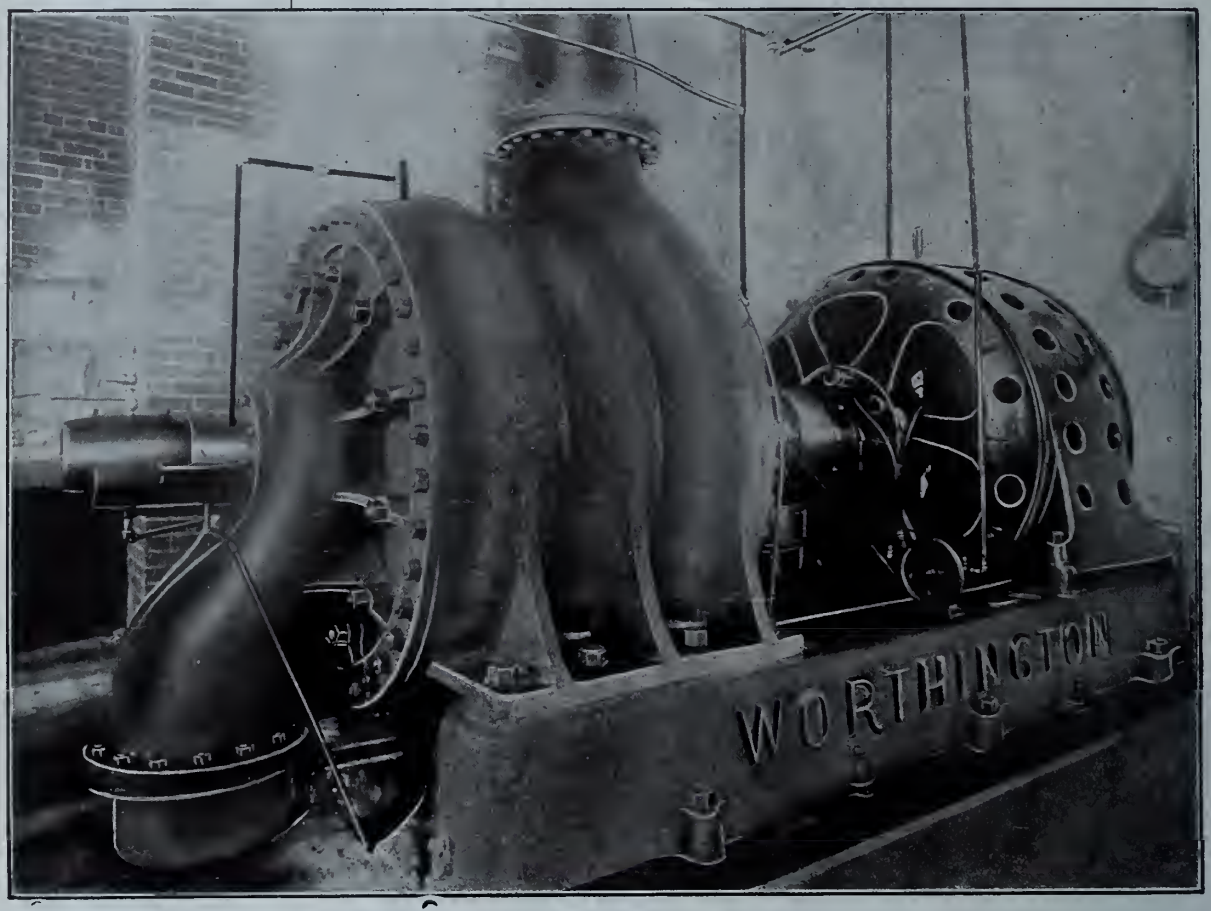
1220-30 Dundas Street, Toronto, Ontario. Canada

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works : Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO August, 1917

How Advertising Protects

A CERTAIN Canadian manufacturer recently received a long distance telephone message, asking him to quote on a lot of equipment required for a certain big undertaking. He caught the first train for the city in which the inquiry originated and as a result closed an order for over $50,000!

This manufacturer took the trouble to come into our office one day this week and frankly told us of the circumstances under which the order referred to had been secured. It developed that the manufacturer in question knew absolutely nothing about the tender being out and it was solely through the appearance of a full page advertisement in our paper that he received the inquiry which resulted in the order for $50,000.

Here was a manufacturer, a keen wide-awake man, with a supposedly efficient sales organization, equipped for keeping in touch with all worth while developments. Had this manufacturer relied solely upon his sales staff he would have lost out but, as we said before, being keen and wide-awake, he had provided for just such contingencies by *advertising*.

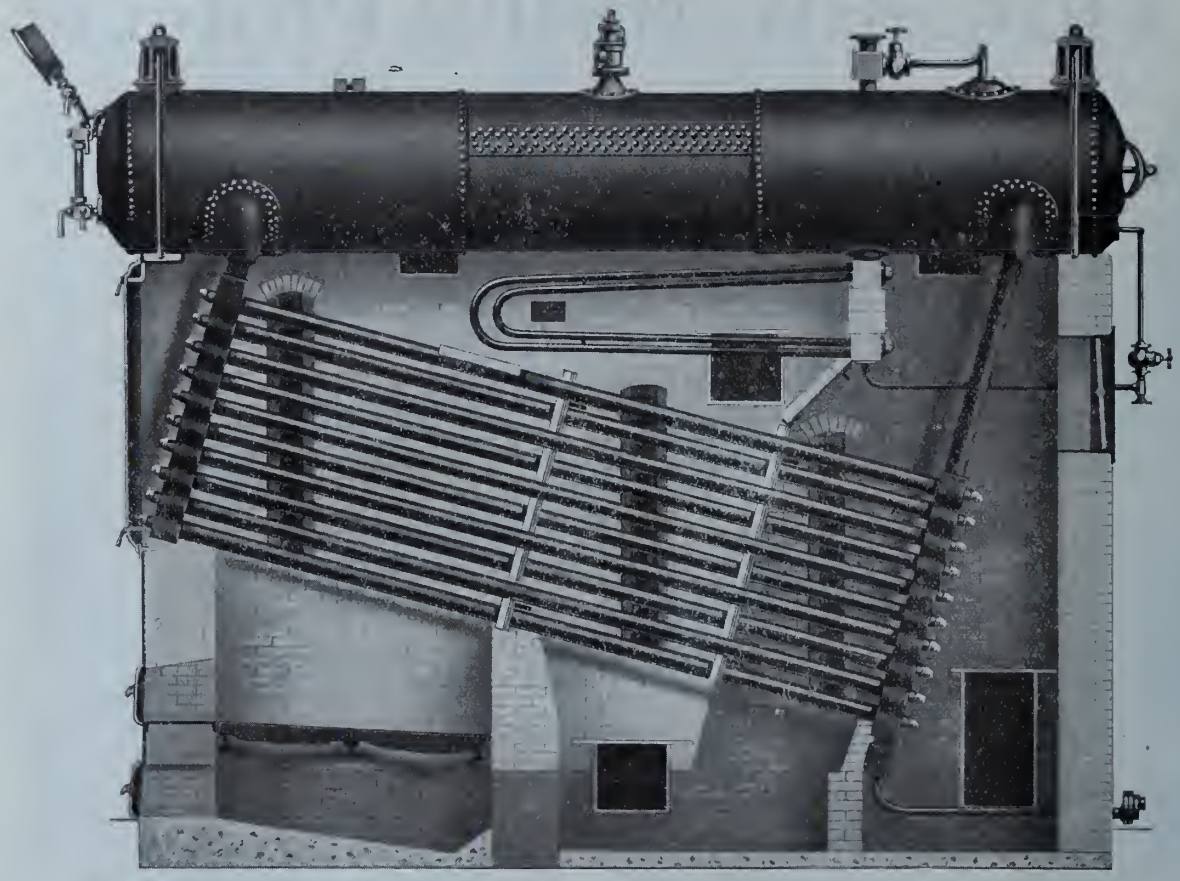
Advertising—the salesman who is everywhere at all times, who never sleeps, who is ever on guard,—proved his worth in this case just as he has shown his mettle so often before.

Even in this instance advertising might not have received the credit for the splendid results secured had not our good friend and advertiser taken the trouble to ascertain just how and why he received the inquiry which led to the order.

Naturally the manufacturer in question asked us for obvious reasons to refrain from mentioning any names at the present time, but the facts were so interesting that we felt impelled to pass them on that a consideration of them might strengthen the already unwavering conviction of those who have advertised long and believe fully in the power of advertising, and encourage those who are almost but not quite convinced that advertising is a necessary force in business. And there are still a few in this state of mind.

G. & McC. CO.

BOILERS



Sectional View, Standard Type "B," Sectional Water Tube Boiler, with Superheater.

G. & McC. Water Tube Boilers are fitted with large Steam and Water Drums, connecting nipples of increased size and straight 4" tubes, all of which insure

POSITIVE AND RAPID CIRCULATION, and INCREASED STEAMING CAPACITY

All parts subjected to steam pressure are made of FORGED STEEL

G. & McC. Engines and Boilers are giving satisfaction in thousands of Canada's leading industrial institutions. Write us for prices, plans, specifications, etc.

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

BRITISH COLUMBIA AGENTS: Robt Hamilton & Co., Vancouver, B.C

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

If any advertisement interests you, tear it out now and place with letters to be answered.

Mechanical and Electrical Equipment of a Modern Hotel

Staff Article

Increased capacity for service in its every departmental feature constitutes one of the chief developments of recent years in the design, construction and equipment of large, modern hotels, both at home and abroad. That the Royal Connaught is a front-ranker with respect not only to artistic appointment, but to the comfort and convenience of its guests will be readily apparent from a study of the mechanical and electrical installation which follows.

THE idea of building the Royal Connaught Hotel in Hamilton, originated with the Board of Trade who felt that there was a need in that city for a first-class hotel to meet the demand of tourists and commercial travellers. The aim of the originators of the scheme was to provide accommodation for the public at medium prices, while for travellers, combination sample and bedroom form a feature.

Hotel Accommodation.

The Royal Connaught is on of the finest hotels in Canada, and no expense has been spared in furnishings and in providing for the comfort of its patrons. The furnishings and decorations were designed and supplied by the T. Eaton Co., of Toronto. The management cater particularly to conventions and social functions, and for this class of business, a number of rooms have been provided having accommodation for guests ranging in number from 7 to 170, while in addition, a large ball room or convention hall forms an attractive feature. The hall is 100 feet by 65 feet and has a seating capacity of 1,000. It has a separate kitchen for use when required for banquets. The hotel has 250 rooms, 200 having bathrooms. They are all outside rooms. The hotel is operated by the Connaught Hotel Co., which is one of the United Hotels Co.'s chain of hotels. It is under the personal management of Geo. H. O'Neil, who is also proprietor of the Tecumseh Hotel, London, Ont. Dudley R. Laver is the chief engineer having charge of the power plant—all the entire mechanical equipment in the hotel.

The Royal Connaught Hotel is of brick and steel construction and is fireproof. The windows have steel sash, with factory wired glass in the bedrooms. The layout of the hotel is modern and a number of new features have been incorporated. Stone and Webster, of Boston, Mass., were the engineers. while Essenwein and Johnson of Buffalo, N.Y., were the architects, with the latter firm was associated A. W. Peene, of Hamilton. The Hamilton Bridge Works had the steel contract and the Yates Co., of Hamilton, the brick contract. The hotel was opened on June 5th. 1916.

Electrical Power Purchased.

The fact that electricity was obtainable at a reasonable rate from the Dominion Power and Transmission Co., of Hamilton, eliminated the necessity of installing a steam power plant. Direct current, however, was required for the elevator motors and to provide for these, motor-generators were installed. The electrical installation, however, is important and very efficient, and forms an interesting feature of the hotel. The electric motors of which there are a considerable number, operate on alternating current, with the exception of those for the elevators. A number of machines in the kitchen are operated by motors, while the machinery in the laundry is also motor driven. There are altogether 32 motors in the hotel, aggregating 356½ h.p., these include, in addition to those mentioned above, motors for the various pumps, fans and refrigerating plant. The alternating current for the motors is 3 phase, 66 cycles and 220 volts, while the direct current for the elevator motors is 250 volts. The current for the lighting system is alternating, 3 wire, 110 volts.

Plant Location

The power plant is located in the basement of the hotel, and includes a room containing the motor generator sets and ammonia compressors for the refrigerating plant. Adjacent to this room is the boiler room and the pump room. Above the pump room on a mezzanine floor is the hot water heating outfit, the drinking water filter and vapour tank for the heating system. The refrigerating room is near the boiler room and on the same level.

FRONT ELEVATION, ROYAL CONNAUGHT HOTEL.

Switchboard Feature.

It will be in order to describe the switchboard first, as all the power required for operating the plant is received here before being distributed. The switchboard and instruments were supplied by the Canadian Westinghouse Co., of Hamilton. L. K. Comstock & Co., of Montreal, were responsible for the layout of the electric end of the plant, both for the power and lighting systems. The switchboard is 15 ft. 6 ins. long by 7 ft. 3 ins. high and has six black slate panels. The first panel controls the main feeders for the lighting system and has an oil circuit breaker for 3 phase 66 cycle 220 volt current. There is also a 110-volt knife switch. This panel has a volt meter for indicating the voltage on the lighting and power mains, controlled by a voltmeter switch. The second panel is for the 100-k.w. motor generator set, which furnishes direct current, 250 volts, for the elevator motors. There are on this panel two triple pole, 500 ampere, knife switches, a circuit breaker, an a.c. ammeter and a field rheostat. The third panel controls the 50-k.w. motor generator set. It has two triple-pole, 400-ampere, knife switches, a field rheostat, a circuit breaker, one a.c. voltmeter for getting voltage on either generator or bus, and an ammeter.

The fourth is the power feed panel, and controls the a.c. motors in the hotel. There are two 50-ampere triple-pole switches for the fans and kitchen motors; two 200-ampere triple-pole switches for pump and laundry motors; two 60-ampere, double-pole, switches, feeding the battery charger and garage elevator motor; two 400-ampere, double-pole, switches feeding the freight, service and passenger elevator motors. The fifth panel controls the lighting feeders to various distributing boards in the hotel. This panel has the following switches:—One 200-ampere, triple-pole switch for east wing switchboard and a similar switch for the north wing. One 100-ampere, double-pole, knife switch for the garage, one 200-ampere, double-pole switch for the laundry and another for the boiler and pump room. The sixth is an extra power panel feeding the fans for the ventilating system. It has one 200-ampere, triple-pole switch for the fans and a 60-ampere switch for a pump. There is a clock on the board which is connected to the clock system.

Motor Generators.

Two motor generator units are installed for supplying direct current for the elevator motors. Both were supplied

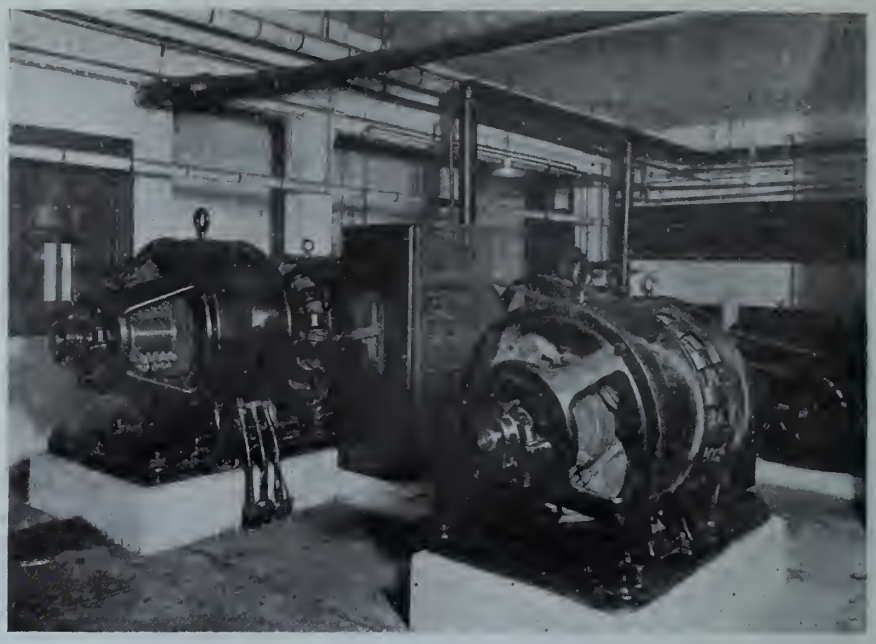
by the Canadian Westinghouse Co. The largest is a 100-k.w. 250-volts, 400-ampere machine, and runs at 970 r.p.m. The motor is 150 h.p., 220 volts, 66 cycle, 3 phase. The generator is 4 pole, compound wound with interpoles. This unit has a Westinghouse type Q auto starter, with overload release.

The second unit has a 50-k.w., 250-volt, 220-ampere generator, with 75-h.p. motor, 220 volts, 202 ampere and runs at 970 r.p.m. This unit has a Westinghouse-type K auto starter.

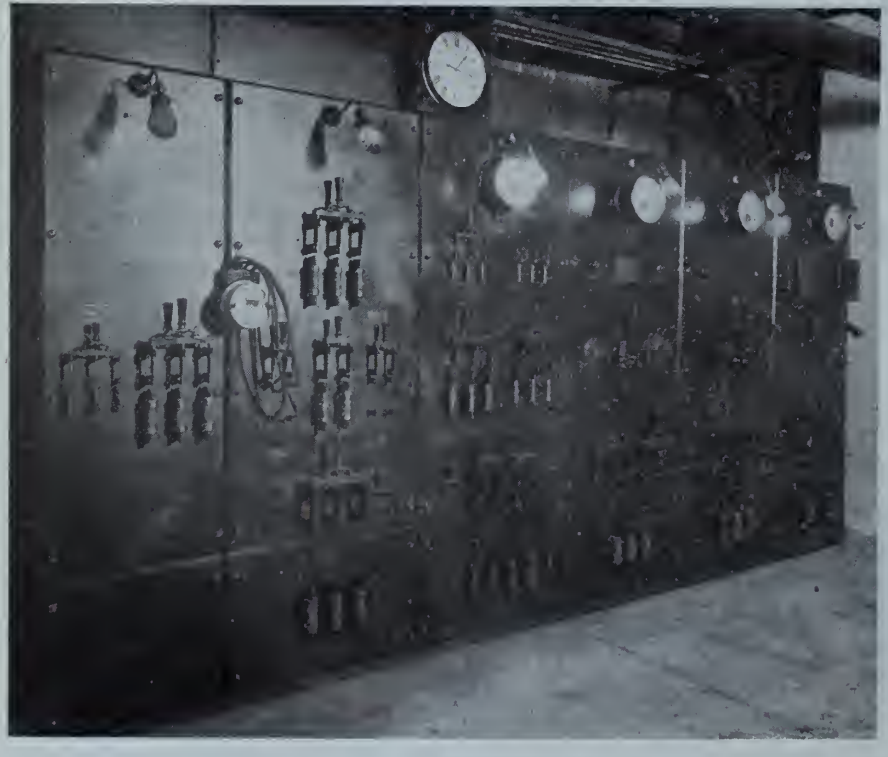
Refrigeration Plant.

The ammonia compressors are located in the same room as the motor generators. They are used in connection with the ice-making plant and the cold-storage system. The refrigeration plant was supplied and installed by the Canadian Ice Machine Co., Toronto. The two compressors are "York" vertical, enclosed machines and have a capacity of 12 and 8 tons respectively. The former has a cylinder 7½ in. diam. by 7½ in. stroke, while the latter is 6½ in. diam. by 6½ in. stroke. The 12-ton machine is belt driven by a 20-h.p. Can. Westinghouse a.c. motor, 220 volts, running at 850 r.p.m. The 8-ton machine is driven by a 15-h.p. a.c. motor, also running at 850 r.p.m. The ammonia condenser installation is situated near the compressors and consists of two double-pipe condensers. 8 pipes high, 19 feet long and made of 1¼-in. and 2-in. pipe. The ammonia receiver is 20-in. diameter by 7-ft. long and the oil trap is 8 in. diam. by 48-in. long. The gauge board has the following: One high-pressure gauge and vacuum gauge, one suction-pressure and vacuum gauge, one water-pressure gauge and one brine gauge.

The combined brine and ice-making tank has a capacity of two tons of ice daily. The tank is 18 feet long, 10 feet wide and 4 feet deep and is insulated with 6-in. of nonpareil sheet cork on bottom and sides. The tank has three double-pipe brine coolers, six pipes high by 16 feet long, made of 2-in. and 3-in. pipe. This is used as a cooling medium for the calcium brine contained in the tank, which is held at approximately 10 to 14 degrees Fahr. The tank also contains 54—8-in. x 16-in. x 32-in. galvanized iron ice cans, each capable of producing a block of ice weighing 100 lbs. Filtered water is used when filling the cans. The same filter is used for purifying the drinking water.



"CANADIAN WESTINGHOUSE" MOTOR-GENERATORS SUPPLYING DIRECT CURRENT TO ELEVATOR MOTORS.



MAIN SWITCHBOARD LOCATED IN MOTOR-GENERATOR ROOM.

There are nineteen refrigerators in the hotel, located principally in the vicinity of the kitchen used for keeping perishable and cooked food, ice storage and garbage, etc. These refrigerators vary in size, the largest being 43 ft. 6 in. long by 7 ft. wide by 8 ft. high, and containing 1,160 ft. of piping. The majority of these rooms are held at a temperature ranging from 32 to 36 degrees, the principal exception being the ice-cream box, which has a temperature of 5 degrees. These refrigerators are fitted with 1¼-in. brine coils, the total amount of piping being 2,600 feet. The brine is pumped from the ice tank through the coils by a Smart-Turner centrifugal pump, having a capacity of 100 gallons per minute and direct connected to a 7½-h.p., a.c. motor, Canadian Westinghouse make running at 1,700 r.p.m. The Canadian Ice Machine Co. supplied the coils and the refrigerators were furnished by the Canadian Jewett Refrigerator Co. A motor-driven ice crusher supplied by the Allman Gas Engine Co., New York, and a motor-driven cube ice cutter, built by G. S. Blakeslee & Co., of Sarnia, Ont., are installed near the brine tank.

The drinking water for the hotel is filtered and cooled, the apparatus for this purpose being situated on the mezzanine floor over the pump room. The water is first passed through a York charcoal filter, 18 in. diam. by 24 in. deep. It then flows to a galvanized steel tank, 5 ft. diameter by 5 ft. 6 in. deep, which contains 460 feet of 1¼-in. galvanized direct expansion coils for cooling water to 40 degrees. The water is pumped to a tank at the top of the building, from where it circulates to the drinking-water faucets. The pump is Smart-Turner make, and it has a capacity of 38 gallons per minute. It is direct connected to a 5-h.p. Can. Westinghouse motor running at 1,700 r.p.m.

The water for filling the cans, after passing through the charcoal filter, men-

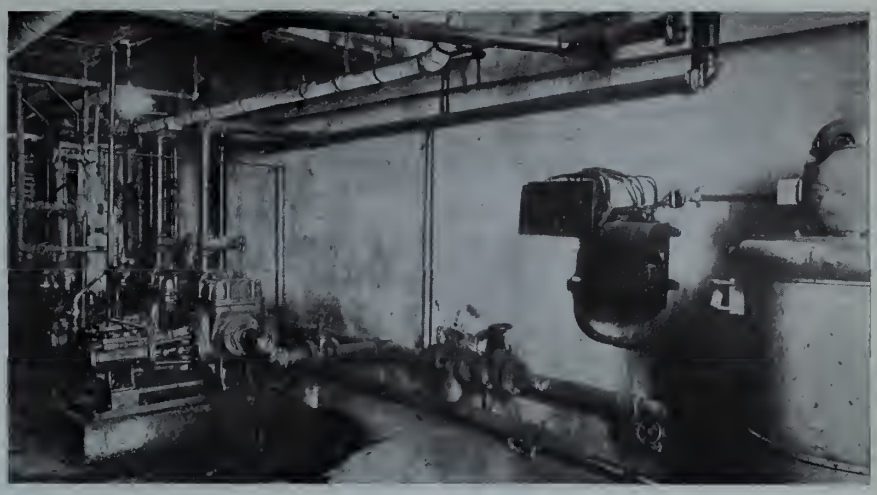
tioned above, goes to a galvanized steel tank 4 ft. diam. by 4 ft. 6 in. deep, which contains 100 ft. of 1¼-in. galvanized direct expansion coils. This water is cooled before going to the cans, so that the temperature of the brine in the ice tank will not be materially affected, as it would be otherwise.

Heating and Ventilating.

At the present time, the Dominion Power Transmission Co. are supplying steam to the hotel under contract, for heating and also for the laundry and kitchen, etc. The reason for this arrangement is that the power company, whose plant is quite near the hotel, can supply steam at a low rate, owing to the fact that they have an ample supply available all the year round. Under prevailing conditions, considerable economy can be effected by this arrangement. The hotel, however, has an independent heating plant for use in case of emergency.

The steam from the Dominion Power Co.'s plant comes in at a pressure of 80 lbs. through a 6-in. main, which connects with the hotel system in the boiler room, where is installed a General Electric Co.'s type M recording steam flow meter for registering the amount of steam taken from the incoming main. A ¾-in. American trap is installed in this line to take care of the drains.

The emergency boiler was built and supplied by the Goldie & McCulloch Co., of Galt, Ont. It is of the water-tube, single-drum type, 125 h.p. It is built for a working pressure of 165 lbs. per sq. in., but is only operated, when in use, at 80-lbs. pressure. There are two Foster reducing valves installed in the system, one for reducing the high pressure steam down to 40 lbs. for the kitchen, and the other for the heating system, which uses steam at about 3-lbs. pressure. The steam in the line to the laundry is at boiler pressure, 80 lbs. Steel piping is installed throughout for the high-pressure steam lines. The valves are mostly of Jenkin Bros.' make.



VACUUM AND BOILER FEED PUMPS. "TUEC" VACUUM CLEANER AT RIGHT.

The high-pressure steam lines are covered with magnesia pipe covering, and the low-pressure steam with cellular covering.

The hotel is heated by means of radiators, fitted with Dunham traps and Canadian Detroit Lubricator Co.'s packless valves. Two Bawden vacuum pumps are installed in the pump room for taking care of the returns from the heating system. Further reference will be made to these pumps later on. The vapor tank for the vacuum pumps is located on the mezzanine floor above the pump room.

The gauges for the steam distribution system are mounted on a board in the motor generator room. The gauges were supplied by Schaeffer & Budenberg, of New York, and comprise the following: One steam-pressure recorder on high-pressure line, one laundry steam-pressure gauge, one gauge for the steam line to kitchen, one gauge for the heating system pressure and one to show the vacuum in the return main. There is one gauge for the vacuum cleaner and one to show the city water pressure.

The distribution system for the heating, hot and cold water, etc., is an interesting one. All piping is carried up an air shaft, inside the building, to a plumbing loft above the eleventh or top floor. The distributing pipes are returned down sixteen smaller shafts from which connections are made to the various rooms, etc. The chimney from the boiler is also carried up the big air shaft.

The ventilating system comprises four motor-driven fans, supplied by Sheldon's Ltd., Galt, Ont, The main ventilating fan is located in a pent house on the roof. It is a double fan, one exhausting from the kitchen and the other from the main air shaft through which the piping referred to above is carried. Connections are made from the corridors with this air shaft. The foul air from the kitchen is carried up to the fan through a galvanized iron duct run up the wall outside the building. This fan is driven by a 20-h.p. Can. Westinghouse a.c. motor running at 1,245 r.p.m. There is another exhaust fan in a pent house on the roof for ventilating the lavatories and bathrooms. This fan exhausts from the plumbing loft, connection being made to the lavatories, etc., by means of the sixteen air shafts. This fan is driven by a 7-h.p., a.c. motor at 1,245 r.p.m.

On the second floor over the hotel annex are two other fans, one for ventilating the laundry, engine and boiler room, and the other for the convention hall. The former is driven by a 7½-h.p. motor running at 1,245 r.p.m., while the latter is driven by a 5-h.p. motor running at 945 r.p.m. The motors are all Canadian Westinghouse make.

8 AND 12-TON "YORK" AMMONIA COMPRESSORS.

Pumping Installation.

This installation comprises the boiler-feed pumps, vacuum pumps, booster pump for cold-water service and stirrup pumps. There are two pumps for the boiler, both being the same make and size. They are duplex horizontal, 5¼ x 3½ x 5 in. Smart-Turner pumps. There are two vacuum pumps, both supplied by the Bawden Pump Co., Toronto. These are horizontal pumps, 6 x 3 x 10 in. and draw the returns from the heating system and deliver to the receiver. The

pumps are controlled by a Fisher governor. This receiver collects all the returns from the various steam lines. The returns from the kitchen are taken care of by a ½-in. Anderson trap and those from the laundry by a 1¼-in. Anderson trap. There is a sump under the pump room floor for collecting seepage and drips from the pumps, etc. In the sump is a 150 gal. Smart-Turner centrifugal pump driven by a 1-h.p. motor running at 1,245 r.p.m. and controlled by a Hamilton Motor Works float switch.

The hotel water supply enters the building in the pump room. It comes in from the city main through a 4-in. pipe and passes through a "Trident" meter up to a tank on the roof. As a precaution against the city pressure dropping, a booster pump is installed. This unit is a 2-in. Kerr vortex turbine pump driven by a 7½-h.p. Crocker-Wheeler a.c. motor running at 1,720 r.p.m. The pump is equipped with a "Sundh" auto-starter working in conjunction with a float in the tank on the roof. In the basement are two sewage pumps, located in a sump, which collects the effluent from the basement lavatories and other drains. They are both Smart-Turner centrifugal pumps, having a capacity of 100 g.p.m., each driven by a 2-h.p. motor operating at 940 r.p.m., and controlled by a "Sundh" float switch.

INTERIOR OF HOTEL LAUNDRY.

The plant for providing hot water is situated on the mezzanine pump floor. The water in the storage tank is heated by two Alberger heaters using low-pressure steam. The temperature of the water is controlled by a No. 11 tank regulator, self-contained type, supplied by the Canadian Powers Regulator Co., Toronto. The hot water is held at a temperature of 160 degrees Fah.

Elevator Installation.

The elevators were built and installed by the Otis Fenson Elevator Co., and comprise two passenger, one service, and one freight elevators. There is also an elevator in the garage at the back of the hotel. This elevator, while not part of the hotel installation, is operated by power from that plant.

The two passenger elevators are single-screw, worm-gear, traction type, having a capacity of 2,500 lbs. They have a speed of 300 ft. per minute, with a load of 2,000 lbs. The cars are 6 ft. by 6 ft., and they have a travel of 126 ft. These elevators are equipped with flash-light annunciators and electric interlocks, which prevent cars starting when the doors are open.

The service elevator has a maximum capacity of 2,500 lbs. and a speed of 200 ft. per minute, with a load of 2,000 lbs. The car is 6 ft. by 6 ft. and travels 139 ft. 6 ins.

The freight elevator has a capacity of 3,000 lbs. and a speed of 150 ft. per minute. This elevator has a travel of 39 ft. 11 ins. and the car is 6 ft. by 8 ft. The machines are located overhead in all cases.

The garage elevator is a special single belt, worm-gear type, having a capacity of 3,500 lbs. and a speed of 40 ft. per minute. The car is 8 ft. by 16 ft. and has a travel of 9 ft. 6 in. The elevator in all cases is operated on 250-volt, a.c. current from the motor generators in the hotel basement.

Lighting System.

The lighting is a 110-volt, 3-wire, a.c. system, and was installed by L. K. Comstock, of Montreal. The wiring is carried from the main switchboard to the distributing wall boards situated in the basement which control various sections of the hotel. On each floor, there are two enclosed wall panels having fuses for various circuits and controlled from the above-mentioned basement switchboards. All these switchboards and fuse panels. etc., were supplied by the Canadian Krantz Co., Toronto. All the wiring is run in galvanized conduit.

Laundry.

A laundry is operated for the benefit of the hotel guests only, and a seven-hour service is maintained. All the equipment was supplied by the Canadian Laundry Machinery Co., Toronto, and consists of the following:—Three brass-cylinder, 125 shirt washers, one tumbler, two 28-in. hydro-extractors, one dry tumbler, one "Hurricane" steam-heated dry room, one steam-heated body ironer, one 30-in. collar machine, three complete electric ironing boards, one electric collar molder, one gravity seam dampener, one four-roll, extra flatwash ironer, American type, one starching tub, one "Uneeda" collar starcher, one steam bosom board and a full line of press machines. The line shaft is operated by a 10-h.p. Can. Westinghouse motor, while some of the machines are motor driven.

Kitchen Motors.

The kitchen is spacious and the equipment is up-to-date in every respect. The kitchen is situated in the basement and adjoining it are the store rooms, pantries and staff mess rooms, etc. In connection with the kitchen equipment, it may be of interest to give the sizes of motors for the various machines, these are as follows: Knife cleaning machines, 1-3 h.p.; dish washer, ¾ h.p.; ice-cream freezer, 2 h.p.; potato peelers, ¼ h.p.; meat chopper, 1 h.p., and coffee grinders, ¼ h.p. These are all a.c. motors and of various makes.

Miscellaneous Features.

An efficient fire protection system is installed in the hotel. Two stand pipes running up to the top of the building are connected to the city mains and also to the water tank on the roof, the latter being an emergency arrangement. There are hose connections on each floor and in addition, there are hand fire extinguishers.

A watchman's clock system is installed, with stations on each floor, making a total of 26. There is a recording apparatus in the hotel office connected to the stations.

A time clock system is also installed, being supplied by E. Howard & Co., Boston, Mass. A master clock on the mezzanine floor near the private office controls thirty clocks located in various sections of the hotel. The system is operated from storage batteries.

The machine for the vacuum cleaning system is installed in the pump room. It is a 6-sweeper "Tuec" unit and handles 1,200 cub. ft. of air per minute. Operation is by a 10 horse-power a.c. motor. The outlets are located at different points on each floor, so that a maximum length of 50 feet of hose can reach all parts of the building. The hose is 1¾ in., and the tools are specially designed to give most efficient cleaning. The risers are all 2½-in. pipe, giving thereby free passage and eliminating all tendency to clogging up.

The horsepower of an engine may be increased within the working capacity of the reciprocating parts by increasing the speed or by increasing the steam pressure.

Test Data Relative to Uniflow Steam Traction Engines*

By F. W. Marquis

This paper presents the results of two series of tests of Baker uniflow steam traction engines, many of them being shown graphically in the form of curves. The steam consumption of these engines is compared with those representative of the older or counterflow type of prime movers, and the conclusion is reached that the simple uniflow engine operating non-condensing with saturated steam has a lower steam consumption than the compound counterflow engine under like conditions and that, when operating non-condensing but with superheated steam, it will have approximately the same steam consumption as a compound counterflow engine when condensing and using saturated steam.

AT FIRST thought it seems strange to find refinements such as the uniflow cylinder and the superheater in connection with traction engines; but when it is remembered that the latter are used extensively in certain districts where fuel is very expensive, and water has to be hauled many miles, the reason for taking advantage of every means for reducing coal and water consumption becomes readily apparent.

Efficiency tests covering uniflow steam traction engines made by the A. D. Baker Co., Swanton, Ohio, have been carried out on two occasions, the first during the year 1915, and the second during 1916. The engine tested in the latter year was almost identical with that tested during 1915, the exceptions being that the 1916 boiler was supplied with a smokebox type of superheater, and its water heating surface was 24½ per cent. greater; in addition the 1916 engine piston displacement showed an increase of 8½ per cent. Both engines were of the makers' standard designs except for the uniflow cylinder and superheater, which were then in process of development. The principal dimensions of both engines are given in Table 1, and besides the uniflow cylinder and the superheater, a feature of particular interest is that of the valve gear, a description of same being included.

Figs. 1 and 2 show cross sections through the uniflow cylinder and valves. As well as triple ported admission valves there is an auxiliary exhaust valve which causes the point of compression to come late in the stroke, instead of at the point where the piston covers the main exhaust ports as is the case with uniflow engines not provided with some form of auxiliary exhaust valve.

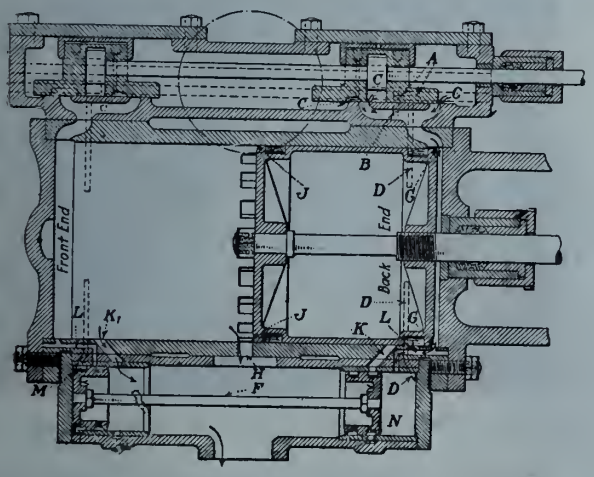


FIG. 1. BAKER UNIFLOW CYLINDER AND VALVES.

	Engine used in 1915	Engine used in 1916
ENGINE		
Nominal horsepower	16	18
Nominal r.p.m.	240	240
	In.	In.
Diameter of cylinder	8¾	9¼
Stroke	10½	10
Diameter of piston rod	1¼	1½
Diameter of flywheel	36	38
Face of flywheel	10	11
Diameter of cranksbaft	3	3½
Length of cranksbaft	55½	61½
Diameter of crankpin	2½	2½
BOILER		
Number of tubes	40	54
	In.	In.
Outside diameter of barrel	29	32
Lengtb of firebox	36	40
Width of firebox	22½	25
Diameter of tubes	2	2
Lengtb of tubes	78	72
	Sq. ft.	Sq. ft.
Grate area	5.56	6.94
Firebox heating surface	23.6	29.1
Tube heating surface	123 2	153.6
Total water beating surface	146.8	182.7
Superheater heating surface		47

TABLE 1. PRINCIPAL DIMENSIONS OF BAKER UNIFLOW TRACTION ENGINES.

Valve Operation

The operation of the valves can best be explained by following their movement as the piston moves through one stroke. Suppose the piston to be moving towards the right and nearing the end of its stroke; that is, that it is just a little to the left of its position in Fig. 1. The admission valves (at the top) will then be a little to the right of the position shown, and moving towards the left. The auxiliary exhaust valve F (at the bottom of the figure) will be at the extreme right end of its travel, and stationary.

When the edge J of the piston uncovers the ports at the centre of the cylinder, exhaust commences. About the same time the cavity A in the admission valve uncovers the port at the end of passage B and allows live steam to flow from E (see Fig. 2), through passage B, cavity A and passage D into chamber N at the end of auxiliary exhaust valve F. This causes valve F to move to the extreme left of its travel, closing the auxiliary exhaust port K and opening the auxiliary exhaust port K^1. Exhaust is then taking place both through the main exhaust ports and through exhaust port K^1. An instant after the auxiliary exhaust valve moves and just before the piston reaches the end of its stroke, admission takes place through the three ports C.

As the piston starts on the return stroke towards the left, exhaust takes place through the main exhaust ports at the centre of the cylinder until, early in the return stroke, they are covered by the piston. The steam still in the cylinder continues to exhaust through auxiliary exhaust port K^1, until the piston covers this port, late in the stroke, when compression starts. Meanwhile live steam has been admitted on the other side of the piston until the admission valve has returned and cut-off has occurred. After cut-off and during expansion, the live steam in chamber N, at the head of the auxiliary exhaust valve, is free to expand through passage L and do work on the piston. This passage L enters the auxiliary exhaust valve chamber at such a point that when the valve is thrown some steam is trapped between it and the end of the valve chamber, thus cushioning it and preventing pounding.

The admission valves are driven by a Baker valve gear, which is very similar to the Baker gear now being used extensively in locomotive practice. It is a

*From a paper read before the American Society of Mechanical Engineers.

single-eccentric variable cut-off and reversing gear which maintains equal leads for all cut-offs and in both directions of running. It consists of an eccentric arm A (Fig. 3), connected at one end to the eccentric and at the other end

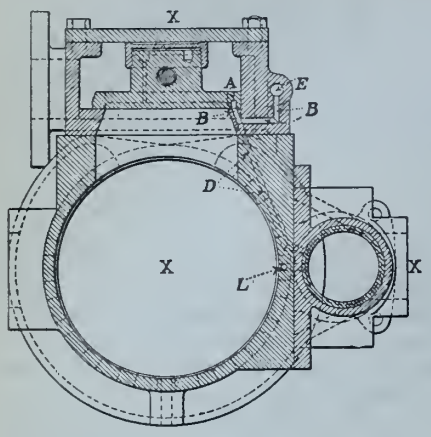


FIG. 2. BAKER UNIFLOW CYLINDER AND VALVES.

to the lower end of radius arm B. This radius arm is supported at the top by a pin C which can be held in place at any point on the arc shown in Fig. 3 by a reverse yoke. The eccentric arm A is connected to the bell crank E by means of the connecting rod F. The valve rod H is attached to the bottom of the bell-crank arm. The eccentric is set exactly 90 degs. ahead of the crank.

When the engine revolves, the eccentric moves one end of the eccentric arm in a circle, and the other end is caused to swing in an arc by the radius arm B. The motion of point P (the point at which the connecting rod F is attached) is then a combination of these two motions. The horizontal arm of bell crank E will then be moved up and down and the vertical arm back and forth, thus driving the valve rod.

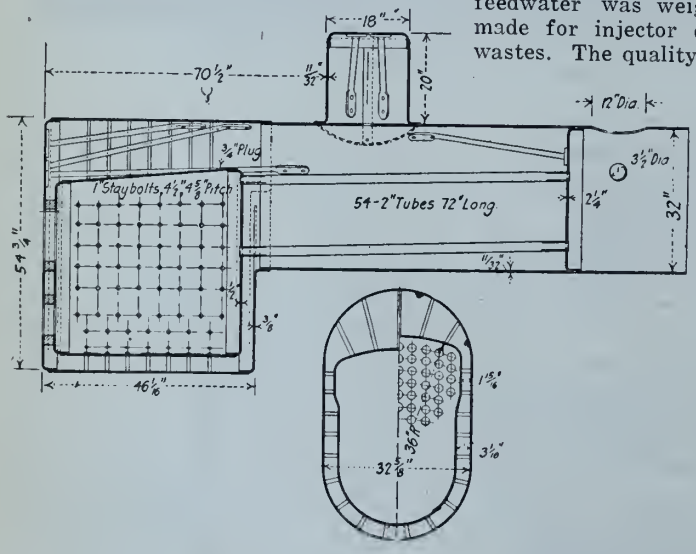


FIG. 4. BOILER OF TRACTION ENGINE.

The point of cut-off is changed and the engine reversed by moving the reverse yoke and thus changing the position of pin C, about which the radius arm B revolves. When the engine is on centre, the end of the eccentric arm and the point of support of the reverse yoke are exactly in line, so there is no motion of the eccentric arm (and valve) when the reverse yoke is moved (engine still on centre). Thus the lead remains constant for all positions of the reverse yoke, i.e., for all cut-offs.

Boiler and Superheater

In Fig. 4 is a drawing of the boiler used in the 1916 tests. It is almost identical with that used in 1915 except that it is a little larger, having 24½ per cent. more heating surface.

In 1916, a superheater was placed in the smoke box. It is shown in place in Fig. 5, and removed in Fig. 6. It consists of a vertical cast-iron header into which tubes are inserted, as shown in Fig. 6. Steam enters through pipe A, Fig. 7, which leads from the steam dome and passes to the front section of the header. It then passes back through the ½-in. pipes and forward through the 1½-in. pipes into the back section of the header. Thence it passes through pipe B to the steam chest.

Test Procedure

The tests were conducted in the Me-

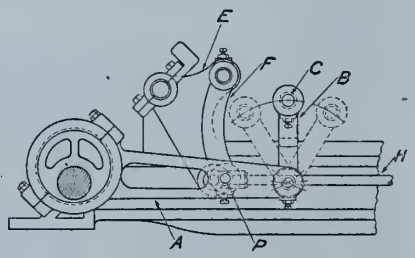


FIG. 3. BAKER VALVE GEAR.

chanical Engineering Laboratory of the Ohio State University and in general the methods recommended in the A.S.M.E. Power Test Code were followed. All coal fired was weighed, sampled, analyzed and the calorific value determined. The feedwater was weighed and correction made for injector overflow and other wastes. The quality of steam was taken

FIG. 5. SUPERHEATER IN PLACE IN SMOKEBOX OF BOILER.

by means of a Barrus throttling calorimeter, the sampling pipe being located in the path of the steam as it left the steam dome. Smokebox temperatures were determined by means of a thermocouple and the smokebox gases were sampled continuously and analyzed by means of an Orsat apparatus. Indicated and brake horsepower and revolutions per minute were all carefully determined. All instruments were calibrated and corrections applied where necessary.

The tests were run with the throttle valve wide open, and except where otherwise noted it was attempted to maintain the speed constant at 250 r.p.m. During the preliminary running preceding each test, the brake load was adjusted so that the desired speed was obtained when the throttle valve was wide open. During each run all conditions were maintained as constant as possible.

Programme of Tests

First Series.—The 1915 series consisted of 17 tests with various boiler pressures ranging from 125 lbs. gauge to 175 lbs. gauge, and various cut-offs ranging from 6 per cent. to 49 per cent. of the stroke. Saturated steam was used throughout this series, and the approximate speed was 250 r.p.m. in all tests.

Second Series.—The 1916 series consisted of 17 tests, 13 at 180 lbs. gauge and 4 at 160 lbs. gauge. Nine of the former were with superheated steam, and four with saturated steam. Superheated steam was used for the four latter tests The cut-off in this series varied from 16 per cent. to 75 per cent. of the stroke. The approximate speed was 240 r.p.m., with the exception of three short runs which were made with variable speed to secure data concerning the relation between speed and power.

Results

A summary of the results having to do with engine performance is given in Table 2, and in Table 3 will be found a summary of results having to do with the boiler, and with the overall performance. Many of these results are also presented graphically in Figs. 9, 10, and 11.

In Fig. 8 are two sample sets of indicator diagrams, one with a rather early and the other with a much later cut-off. They show a remarkable lack of wire-drawing during admission, and sharp cut-off for a slide-valve engine running at such a high speed (250 r.p.m.). The drop in the early part of the expansion line of the diagrams with an early cut-off,

and that in the admission line of the diagrams with the later cut-off, is caused by the steam flowing into the auxiliary exhaust-valve chamber, at the instant the piston uncovers the port leading to this chamber.

The curves in Fig. 9 show the relation between steam consumption in pounds per i. hp-hr. and i.hp. for both the series of 1915 and the series of 1916, under the different conditions of running. Reference to this figure shows that the highest steam consumption obtained was just under 29 lbs., which occurred at 125 lbs. boiler pressure with saturated steam and at approximately 60 i.hp. The lowest steam consumption obtained in any single test was 18.2 lbs. per i. hp-hr., in the series of 1916, with 180 lbs. boiler pressure and 118 degs. superheat, at about 72 i.hp. Reference to the curve shows, however, that this point was abnormally low, the lowest point on the curve being 19.1 lbs. per i.hp. per hour.

The total range of steam consumption, from the most unfavorable conditions of high overload and low boiler pressure (125 lbs.) with saturated steam, to the most favorable conditions of economical load and high boiler pressure (180 lbs.) with superheated steam, was only from 29 to 19 lbs., or 10 lbs.

It will be noticed that at each boiler pressure tests were run with cut-offs considerably later than the most economical. It seems reasonable to assume that the engine should be rated at approximately the point of best economy. On this basis the rating when operating under 125 lbs. boiler pressure would be 45 hp. Tests were run from about 30 to about 60 i.hp. or from about 60 per cent. to 130 per cent. of this rated load, and over this range the variation in steam consumption was from approximately 29 to 26½, or only about 2½ lbs.

If the same reasoning is followed in connection with the tests run at 180 lbs. boiler pressure and with superheated steam, it will be found that tests were run over a range of from approximately 55 per cent. to 145 per cent. of full load, and that the maximum difference in steam consumption over this rather wide range was only from approximately 20½ to 23½ lbs. ,or 3 lbs.

It is interesting to note that the maximum power obtained was 108.7 i.hp. (102.8 b.hp.), which was obtained with 180 lbs. boiler pressure and with 181 degs. Fahr. superheat, and with a steam consumption of only 23.5 lbs. per i.hp. per hour (24.5 lbs. per b.hp. per hour). This becomes particularly interesting when it is remembered that the cylinder diameter and stroke of this engine were only 9¼ in. and 10 in. respectively.

The curves in Fig. 10 show the relation between steam consumption and

TABLE 2. SUMMARY OF ENGINE RESULTS.

Laboratory symbol	Length of test, min.	R.p.m.	Boiler press., lb. per sq. in. gage	Superheat, deg. fahr.	Avg. cut-off, per cent of stroke	I.hp.	B.hp.	Mech. eff'y	Wt. of dry steam per i.hp. per hr., lb.	Wt. of dry steam per b.hp per hr., lb.	Eff'y ratio based on i.hp., per cent
1	2	3	4	5	6	7	8	9	10	11	12
SERIES OF 1915											
1-125-1	300	246.9	125 6	0	15.1	30 75	27 8	90 4	27 65	30.55	55 9
2-125-3	240	252.3	125.2	0	31.7	47 38	42.8	90.4	26 45	29.25	68.3
3-125-5	180	259.3	125.0	0	48 9	59 90	54 3	90.9	28 95	31.92	53 7
4-140-1	240	247.6	141.5	0	15.1	37 58	32 8	87.4	25.45	29.15	58.5
5-140-3	180	269.5	139.5	0	31.7	58 48	52 2	89.4	26.00	28.00	60.0
6-140-2	210	263.6	140.7	0	22 3	47.95	42.0	87.7	24.80	28.25	59.7
7-140-5	180	242 0	140 3	0	49.0	68 01	61 2	90.1	28.55	31 75	51.6
8-155-1[1]	240	258.0	155.6	0	15 1	45.82	37.8	82.6	23.35	28.25	61 3
9-155-3	180	254.6	154 7	0	28.1	64 82	56 7	87.6	24.95	28 50	57 6
10-155-2	240	260.0	155 0	0	20.4	55.63	46 4	83 4	23.72	28.77	60.4
11-165-3	180	253 7	165.2	0	28.1	70.00	61.6	88.0	24 40	27.73	57 3
12-165-1	210	260.5	165.0	0	12.0	45.36	39.0	86.1	25.18	29.24	55 8
13-165-2	180	270 0	165.2	0	20 4	59 04	51 8	87 8	....	.....	.....
14-175-1	210	251.7	176.2	0	12 0	48.83	42 7	87 5	24 40	27.90	56.0
15-175-2	180	256.4	175 5	0	20.4	60 93	54 8	90.1	23.32	25.90	59.1
16-175-3	180	258.7	176.4	0	28.1	74.12	66.6	89.8	23.60	26.25	68.3
17-175-0	60	244 8	176.2	0	6.2	33.98	28.0	82 5	26 95	32.65	61.2
SERIES OF 1916											
1-160-3	180	238.5	160.0	124	30.6	61.60	55 9	90.8	19 6	21.6	66.0
2-160-4	180	226.0	160 0	130	41.8	64.90	60.8	95.2	21.2	22.7	60.0
3-160-2	180	232 1	159.5	115	21 3	46 80	42.8	91.5	20 4	22.4	63.0
4-180-1	240	253.0	180 0	115	16 7	39.30	34.2	87.0	20.4	23.4	61.5
5-180-2	240	243 0	178.5	117	21 3	57.30	63.3	93.1	20.0	21.5	62 7
6-180-3	180	245.0	178.3	123	30.6	71.80	65.9	91.8	19.0	20.6	65.4
7-180-4	180	227.0	179 5	136	41 8	79.20	73 3	92.5	20 1	21.8	61.4
8-160-5	180	240.2	158.3	142	50 8	77.90	74.0	95.0	21 7	22.8	60.0
9-180-5	180	253.8	177 4	157	50 5	94.10	87.0	92.5	20.5	22.2	69.2
10-180-3[2]	60	262.3	178.6	131	30.6	73.40	67.6	92.2	19.6	21.3	62.5
11-180-3[2]	60	230.1	180 0	118	30 6	72.30	68.2	94.3	18.2	19.3	67.6
12-180-3[2]	15	257.0	180.0	127	30.6	71 30	66.1	92.8	.....	.....	.....
13-180-8[2]	30	294 6	181.0	181	74.7	108.70	102.8	94.5	23 6	24.5	58.5
14-180-2	180	240.8	179.3	0	21.3	52.70	49.4	93.7	26.7	28.1	50.9
15-180-3	180	245.0	179.0	0	30.6	67.60	64.7	95.8	24.7	25.6	55.2
16-180-4	120	245.0	178.5	0	41.8	79.00	74.0	93.7	25.7	27.2	50.3
17-180-3	180	238.0	178.7	0	30.6	66.20	62.8	94.8	24.7	25.7	56.6

Column 1: Laboratory Symbol. The first term represents the number of run; the second the approximate boiler pressure and the last the position of the reverse lever upon its quadrant expressed in notches from the center back.

Column 12: Efficiency ratio, based on i.hp. This is the ratio between the thermal efficiency of the engine and the thermal efficiency of a perfect engine operating on the Rankine complete expansion cycle. It is equal to $2545/WH$, where W = actual wt. of steam per i.hp-hr., and H = the adiabatic heat drop from pressure and quality of steam furnished to engine to exhaust pressure.

[1] Valve setting changed between runs No. 8 and No. 9.

[2] Runs No. 10, No. 11, and No. 12 are short variable-speed runs. Run No. 13 is a short maximum-power run.

TABLE 3. SUMMARY OF BOILER AND OVER-ALL RESULTS.

Laboratory symbol	Length of test, min.	Boiler press., lb. per sq. in., gage	Superheat, deg. fahr.	Pounds of coal fired per sq. ft. of grate surface per hr.	Equiv. evap'n per sq. ft., water-heating surface per hr., lb.	Equiv. evap'n per sq. ft. total (inc. superheater) heating surface per hr., lb.	Equiv. evap'n per lb., air, dry coal	Efficiency of boiler per cent	Wt. of air-dry coal per b. hp. per hr., lb.	Overall efficiency, per cent
1	2	4	5	13	14	15	16	17	18	19
SERIES OF 1915										
1-125-1	300	125 6	0	22.2	7.62	.....	8.38	57.1	4.67	3.85
2-125-3	240	125.2	0	32.0	11.00	.....	8 45	57.5	4.35	4.10
3-125-5	180	125.0	0	46 1	15.25	.....	8 11	55.2	4.94	3.63
4-140-1	240	141.5	0	25.1	8.59	.....	8 41	57.4	4 45	4 02
5-140-3	180	139 5	0	39.6	12.97	.....	8 02	54.6	4.41	4 04
6-140-2	210	140.7	0	31 6	10 62	.....	8 26	56.3	4.36	4 11
7-140-5	180	140.3	0	53.6	16 90	.....	7 77	52.8	5 10	3 52
8-155-1	240	155.6	0	27.7	9.63	.....	8 46	57 6	4 28	4.18
9-155-3	180	154 7	0	45 0	14 10	.....	7 83	53.3	4.58	3 92
10-155-2	240	155.0	0	36 2	11.61	.....	7.96	54.4	4 53	3.94
11-165-3	180	165 2	0	48.9	14 89	.....	7.57	51.5	4.58	3.00
12-165-1	210	165 0	0	31 8	10 10	.....	7.84	53 4	4.74	3 77
13-165-2	180	165 2	0	38 1	.....	.....	.....	.....	4.29	4 17
14-175-1	210	176 2	0	33.0	10 50	.....	7 88	53 6	4 51	3.08
15-175-2	180	175 5	0	39.7	12 40	.....	7 74	52 6	4 23	4 25
16-175-3	180	176 4	0	49.6	15.20	.....	7 58	51.7	4 34	4 14
17-175-0	60	176 2	0	21.3	8 72	.....	8 87	60.3	4.44	4 04
SERIES OF 1916										
1-160-3	180	160 0	124	27 1	8 12	6 92	8 43	58 6	3.40	5.38
2-160-4	180	160.0	130	32 6	9 13	7 90	7 95	55 3	3 76	4 80
3-160-2	180	159 5	115	22 1	6 47	5.54	8 34	57 9	3 54	6 14
4-180-1	240	180 0	115	18.5	5 47	4 68	8 47	58 8	3 73	4 90
5-180-2	240	178 5	117	26 6	7 71	6 62	8 36	58 0	3.42	5 32
6-180-3	180	178 3	123	31 3	9 13	7 80	8 45	58.7	3 23	5 65
7-180-4	180	179 5	136	37 2	10 65	9 14	8 16	56 7	3 51	5 19
8-160-5	180	158 3	142	38 8	11.26	9 56	8 27	57 5	3 62	5 04
9-180-5	180	177 4	157	45.1	12 80	11.04	8 18	56 8	3 30	5 11
10-180-3	60	178 6	131	32 8	9 60	8 23	8.35	58.0	3 35	5 45
11-180-3	60	180 0	118	29 4	8.74	7 49	8.48	58.9	2 98	6 13
12-180-3	15	180 0	127	.....	.....	.....	.....	.....	.....	.....
13-180-8	30	181.0	181	62 6	16.77	14 72	7.20	50 0	4.58	3 98
14-180-2	180	179.3	0	26.9	8 71	.....	8 24	57 2	3 83	4.77
15-180-3	180	179.0	0	36 6	11.15	.....	7 97	56 4	3.92	4 64
16-180-4	120	178 5	0	42 8	13.38	.....	7.36	51.4	4.50	4 06
17-180-3	180	178 7	0	35 4	10 80	.....	8 18	56.8	3.86	4.73

Column 1: Laboratory Symbol. The first term represents the number of run; the second the approximate boiler pressure, and the last the position of the reverse lever upon its quadrant expressed in notches from the center back.

Columns 16 and 17: The superheater, when used, is considered to be a part of the boiler.

Column 19: Overall Efficiency. The ratio between the heat equivalent of the work done at the brake pulley per lb. of air-dry coal fired and the heat value per lb. of air-dry coal.

FIG. 6. SUPERHEATER REMOVED FROM BOILER.

boiler pressure. As the boiler pressure increases, not only does the steam consumption decrease, but also the power at any cut-off, and the power at which

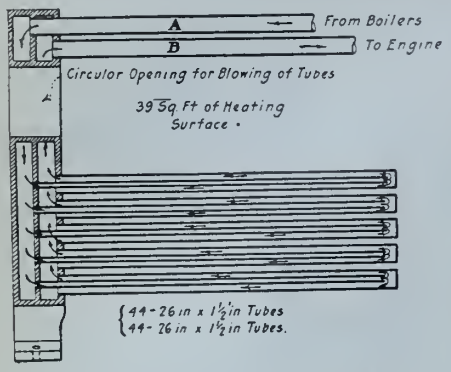
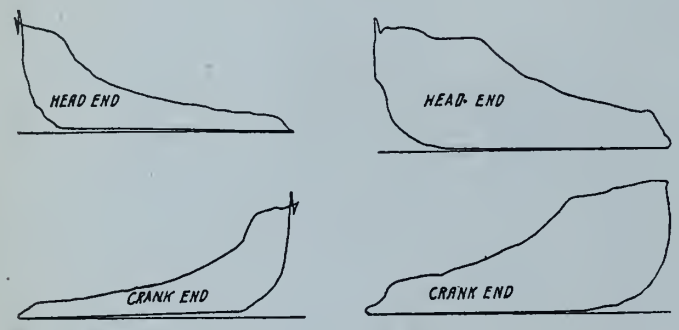


FIG. 7. DIAGRAM OF SUPERHEATER.

the lowest steam consumption occurs in-increases. Curve A shows the decrease in steam consumption with increase of boiler pressure at 50 i.hp., and curve B at 60 i.hp. Curve C shows the relation between the minimum steam consumption at each boiler pressure, and the boiler pressure. The power corresponding to minimum steam consumption at



Run No.1. Series of 1915. 125 lb. Boiler Pressure, Saturated Steam.

Run No.7. Series of 1916. 180 lb. Boiler Pressure, Superheated Steam.

FIG. 8. SAMPLES OF INDICATOR DIAGRAMS.

each pressure is shown by the figure near each point through which this curve is drawn. It will be noticed that, with the exception of one point on this curve, the power of minimum steam consumption increases as the boiler pressure increases.

Curve A shows that at 50 hp. the steam consumption decreases from 29 at 125 lbs. to 23.4 lbs. at 175 lbs. pressure, while curve C shows that, if the point of minimum steam consumption at each boiler pressure is taken, the decrease is only from 26.4 lbs. at 125 lbs. pressure to 23.3 lbs. at 175 lbs. pressure.

The curves of Fig. 11 show the relation between the pounds of coal used per brake horsepower per hour and the brake horsepower developed. These curves are naturally of the same general shape as those given in Fig. 9, showing the relation between steam consumption and indicated horsepower. The inconsistency in results shown by the fact that many points are not located on the curves is caused largely by the facts that it was not possible to maintain uniform conditions of combustion during the different tests, and that it was very difficult to keep the condition of the fuel bed such that there would be the same amount of coal on the grates at the end as at the beginning of a run.

It will be noted that the highest coal consumption was 5.1 lbs. per b.hp-hr., and that this occurred at 140 lbs. boiler pressure and 61 b.h.p., while the lowest coal consumption obtained in any single test was 2.98 lbs. per b.hp-hr., which occurred at 180 lbs. boiler pressure, 118 degs. Fahr. superheat, and 68 b.hp. However, this seems to be an abnormally low value, the lowest point on any curve being 3.27 lbs., corresponding to 180 lbs. boiler pressure with superheated steam and at 67.5 b.hp.

As a matter of interest from a comparative point of view, the steam consumption curves of a number of the ordinary counterflow type of steam engines, both simple and compound, non-condensing and condensing, have been plotted on the same sheet with certain of the steam-consumption curves of the Baker uniflow engine. These curves are given in Fig. 12. Information concerning each of the engines whose steam-consumption curve is given in this figure will be found below:—

Curve A.—Simple, slide-valve engine, cylinder 8 in. by 12 in., initial steam pressure 130 lbs. gauge, non-condensing, and at 200 r.p.m.

Curve B.—Simple, slide-valve engine, cylinder 9 in. by 12 in., initial steam pressure 140 lbs. gauge, non-condensing, and at 290 r.p.m.

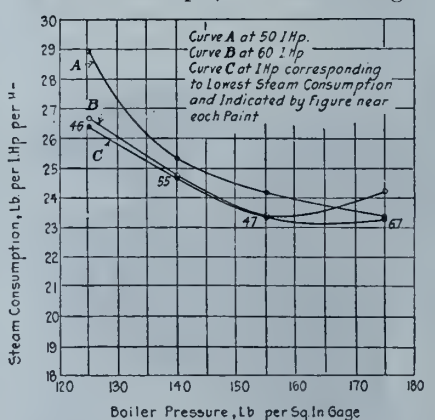


FIG. 10. CURVES SHOWING RELATION BETWEEN STEAM CONSUMPTION AND BOILER PRESSURE, SERIES OF 1915.

Curve C.—Simple, slide-valve engine, cylinder 15 in. by 14 in., initial steam pressure 115 lbs. gauge, non-condensing, and at 225 r.p.m.

Curve D.—Same engine as in case of Curve C, but operating condensing.

Curve E.—Cross-compound, slide-valve engine, cylinders 7 in. and 13 in. by 10 in., initial steam pressure 150 lbs. gauge, non-condensing, and at 310 r.p.m.

Curve F.—Same engine as in case of curve E, but operating condensing.

Curve H.—Tandem-compound, slide-valve engine, cylinders 8¼ in. and 13¼ in. by 12 in., initial steam pressure 115 lbs. gauge, condensing, and at 280 r.p.m.

Curve G.—Simple uniflow engine, cylinder 8¾ in. by 10 ¼ in., initial steam pressure 125 lbs. gauge, non-condensing, and at 250 r.p.m.

Curve I.—Same engine as in case of curve G, but with 175 lbs. gauge boiler pressure.

Curve K.—Simple uniflow engine, cylinder 9¼ in. by 10 in., initial steam pressure 180 lbs. gauge, superheat approximately 130 degs. Fahr., non-condensing, and at approximately 240 r.p.m.

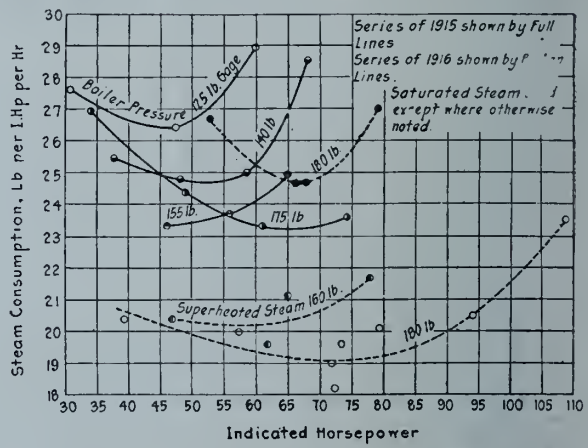

Series of 1915 shown by Full Lines
Series of 1916 shown by Dotted Lines.
Saturated Steam except where otherwise noted.
Boiler Pressure 175 lb Gage
140 lb
180 lb
155 lb
175 lb
Superheated Steam 160 lb.
180 lb
Steam Consumption, Lb per I.Hp per Hr
Indicated Horsepower

FIG. 9. CURVES SHOWING RELATION BETWEEN STEAM CONSUMPTION AND INDICATED HORSE POWER.

Comparisons and Conclusions

It will be seen that the uniflow-engine curves selected are those representing the poorest and the best results obtained with saturated steam, and the best results obtained with superheated steam. A study of this set of curves (Fig. 12), shows that the poorest results obtained with the uniflow engine, namely, those of curve G, obtained with saturated steam at 125 lbs. pressure, are better than the best results obtained with any of the simple engines, even when operating condensing, and almost the same as those obtained with the compound non-condensing engine shown by curve E. The steam consumption of the uniflow engine at 175 lbs. pressure with saturated steam running non-condensing is lower than that obtained with the compound non-condensing engine at 150 lbs. pressure shown by curve E. Also the steam consumption of the uniflow engine with 180 lbs. steam pressure and 130 degs. superheat, was lower than that of the compound condensing engine with 150 lbs. steam pressure shown by curve F.

Thus it is seen that on the basis of the results of the tests reported in this paper and the information presented by Fig. 12, which is thought to represent fairly the average practice for small,

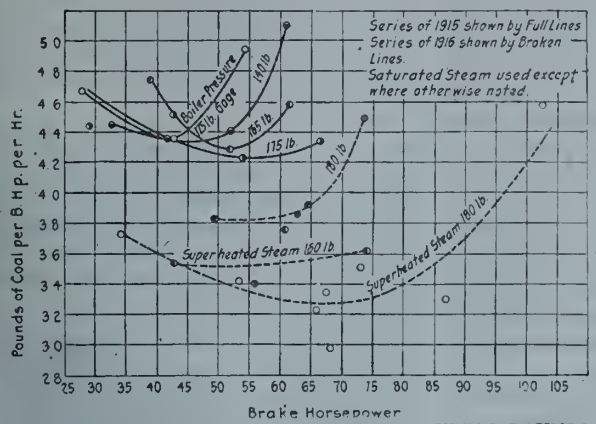


FIG. 11. CURVES SHOWING RELATION BETWEEN POUNDS OF COAL PER B.H.P. PER HOUR AND B.H.P.

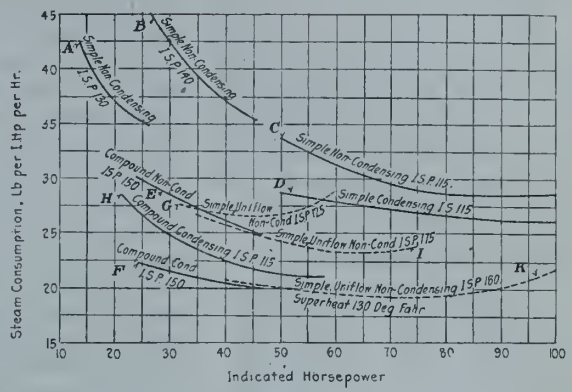


FIG. 12. RELATIVE STEAM CONSUMPTION OF BAKER UNIFLOW ENGINES AND COUNTERFLOW ENGINES.

simple and compound engines of the older or counterflow type, the simple uniflow engine operating with saturated steam and non-condensing, is able to surpass in economy of steam consumption the compound counterflow engine when operating under similar conditions. Also, that the simple uniflow engine operating non-condensing but with superheated steam will have approximately the same, or slightly less, steam consumption than the compound counterflow engine operating condensing but with saturated steam.

On the basis of these conclusions, it seems probable that the simple uniflow engine will prove a serious competitor of the compound counterflow type, since it is not only more economical in its use of steam, but also simpler in construction, and probably on that account lower in first cost.

LOCO. BOILER EXPLOSION

A RAILROAD locomotive boiler exploded recently and caused the death of five men and the injury of another. It will be seen that the crown sheet failed, which is a common method of failure with boilers of this type. The explosion is said to have been due to low water, which caused the crown sheet to become overheated. It is reported that the locomotive had been overhauled not long before, and that it had been in service but a day or two before the explosion occurred.

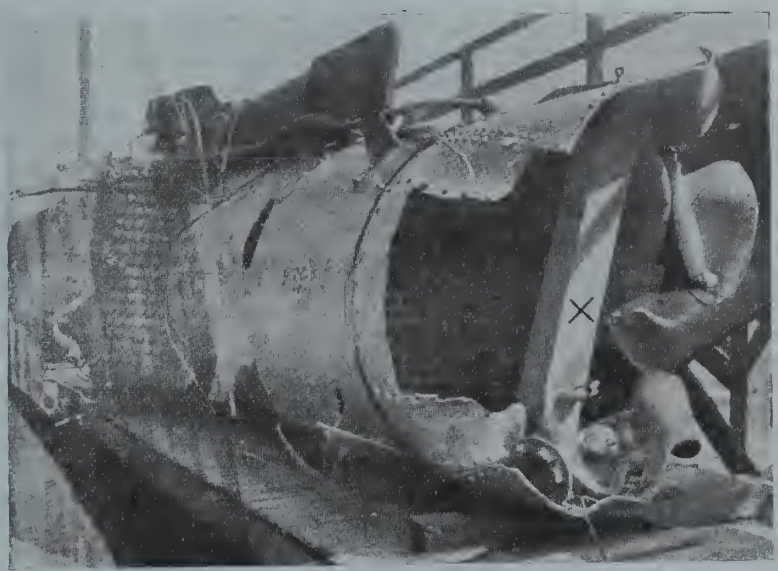


FIG. 2. FRONT END OF BOILER. NOTE RAILROAD TIE X WEDGED INTO SMOKEBOX.

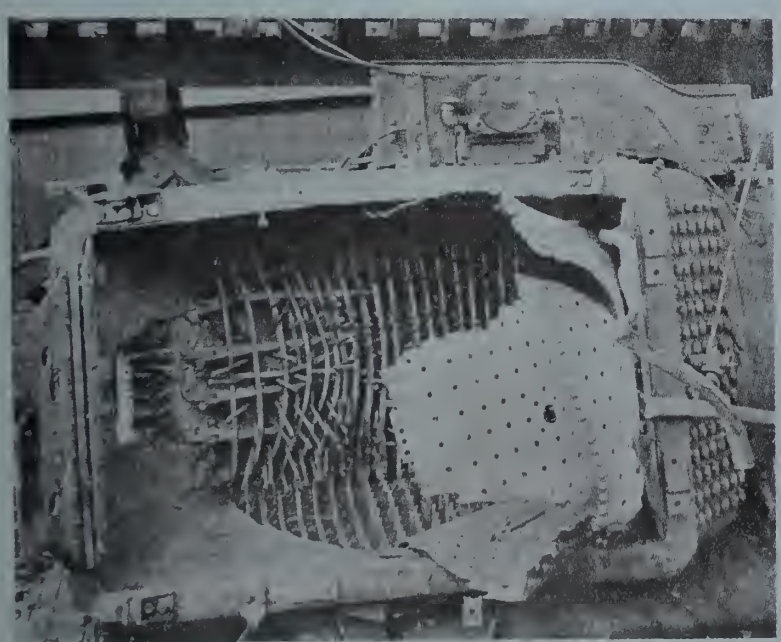


FIG. 1. SHOWING THE FURNACE AND CROWN SHEET.

The boiler was built in 1905. The waist or shell was 69½ inches in diameter, and there were 273 tubes, each 2 inches in diameter and 162½ inches in length. The working pressure was 205 pounds. We are informed says the Travelers Standard, that when the explosion occurred the boiler was torn from the locomotive trucks and was blown over a signal tower about 50 feet distant. It turned over twice during its flight, and landed about 124 feet from the spot where it started. At some time during its journey the front end of the boiler fell upon the right of way and cut off a railroad tie, which is shown wedged between the opposite sides of the front course of the boiler in Fig. 2. It is easy to imagine the extreme havoc that would have been wrought by the explosion if this had been a stationary boiler located in the boiler house of a power plant.

COAL VERSUS WOOD FUEL

By D. Street

THE rising cost of coal, as well as of other articles of all kinds necessary to industry has turned the attention of many users of coal to the possibilities of wood, and if the change is made from one class of fuel to the other certain necessary conditions must be carefully observed. The chemical composition of wood, when dried to 140 deg. Fahr. varies very little indeed, and the constituent parts of the various woods are as follows:—

FOR COAL VS. WOOD.

	Carbon	Hydrogen	Oxygen	Nitrogen
Beech	48.98	6.07	43.11	0.93
Oak	50.64	6.03	42.05	1.28
Birch	50.61	6.23	41.04	1.12
Aspen	50.31	6.32	42.39	0.98
Willow	51.75	6.19	10.98	0.98

The first three are hard woods, weighing about 50 lbs. per cubic foot, whilst the latter woods weigh about 35 lbs. so that the reputation of the heavier woods for producing more heat must arise from their greater density and smaller capacity for holding water. Their carbon and hydrogen content, per pound, is very much alike. The ash left by wood when completely burned varies from ½ to over 3 per cent.

Moisture in Wood

Wood, when felled, contains from 20 to 50 per cent. of water, and seldom even after storing has less than 15 per cent. while if brought during the rains it may have very much more. A purchaser should therefore be very careful to ascertain the amount of water in his fuel to adjust the price properly. Wet wood, when burnt by raising half of its weight in steam that passes uselessly into the chimney, may make a very unsatisfactory fuel. The amount of moisture in a supply of wood fuel may be ascertained by splitting several logs through the middle and planing an equal quantity of shavings from each. Mix the shavings and select a one pound sample to be dried in the air until it ceases to lose weight, and another pound to be dried carefully above the boiler, noting the temperature of the air among the shavings and weighing. The experimenter will then be able to ascertain the percentage of moisture in the wood when air-dried and stove-dried. In England dry wood is worth, for the purpose of steam raising, half its weight in English coal having only 5 per cent. of ash, but when the ash in coal amounts to 22 per cent, the ratios of value are considerable altered in favour of wood.

Much depends on the way in which wood is burnt. If used in large pieces there will be considerable spaces between them, and the total amount in the state of combustion will be reduced. There may also be an excess of air drawn through the fire. The fire bed, when wood is used, is more difficult to manage, and for the control of the draught it is well to have a door on the ashpit. When using wood fuel it is desirable to have the means of cutting it up cheaply into pieces of such a size as may be fed easily into the fire and properly managed for burning. A Cornish boiler has a more convenient furnace for wood burning than a Lancashire one on account of the greater size of the furnace flue and greater flame space, but an exterior furnace may be built to greater advantage for room, and is largely used in countries where wood is the only fuel obtainable.

COMPARATIVE BOILER EFFICIENCY TESTS CONDUCTED AT THE PLANT OF GORDON, IRONSIDE & FARES, LTD., WINNIPEG.

OBJECT OF TESTS: TO DETERMINE EFFICIENCY OF THE "GALT" SPRINKLER STOKER OVER HAND FIRING, USING LOW GRADE COAL.

	HAND FIRING.	"GALT" SPRINKLER STOKER.
Kind of fuel used on test	3 of anthracite dust to 1 part bitumin's slack.	4 of anthracite dust to 1 part bitumin's slack.
Type and horse power of boiler.....	Ret. tubular, 125 H.P.	Ret. tubular, 125 H.P.
Duration and date of test.....	(July 3rd) 8 Hours	(June 30) 8 Hours
Average steam pressure—gauge.....	100 Lbs.	100 Lbs.
Average thickness of fire.....	6 Inches	3 Inches
Average temperature of feed water.....	187°	180°
Total cost of coal used on test.....	$16.95	$10.84
Total weight of coal used on test.....	6,800 Lbs.	4,500 Lbs.
Total water evaporated.....	37,590 "	36,500 "
Evaporation per lb. of coal (as fired).....	5.5 "	8.1 "
Factor of evaporation.....	1.068	1.073
Evaporation per lb. of coal from and at 212°	5.9 Lbs.	8.7 Lbs.
Evaporation per lb. of combustible from and at 212°	6.7 "	10.08 "
Per cent. of ashes and refuse.....	15%	13%
Equivalent total water evaporated from and at 212°	40,146 Lbs.	39,164 Lbs.
Cost of fuel to evaporate 1,000 lbs. of water..	45.1c	29.6c
Cost of fuel to evaporate 1,000 lbs. of water at 212°	42.2c	27.6c
Chemical analysis of fuel B.T.U. per lb.....	12.000 B.T.U.	12.000 B.T.U.
Combined efficiency of boiler and furnace....	47.5%	70%
Total heat derived in B.T.U. per lb. of fuel...	5.700 B.T.U.	8.404 B.T.U.
Actual boiler horse power developed per hr...	145	142
Grate area	30 Sq. Ft.	30 Sq. Ft.
Coal burned per sq. ft. of grate per hour.....	28.3 Lbs.	18.7 Lbs.
Nature of draft employed (under grate)	Forced	Forced

The above tests were made by John L. Tully, Mechanical Superintendent of Gordon, Ironside & Fares. The water and coal used on each test was accurately weighed and recorded, and every precaution taken to have both tests conducted under exactly equal conditions.

It will be noticed that 3 parts anthracite dust to 1 part bituminous slack was used on the hand fired test, and 4 parts of the former to 1 part of the latter with the stoker. With hand firing the steam pressure could not be maintained, using the 4 to 1 mixture.

HOW TO PREPARE WHITEWASH

IN view of the fact that boiler room walls and ceilings and, in not a few instances, those of engine rooms are periodically given a coat of whitewash, the accompanying data covering the preparation of the latter may be found handy for reference and for checking its constituent when the work is being done under contract.

Slake half a bushel of lime with hot water, stirring continuously while slaking; strain it and add one peck of salt dissolved in warm water. The proper consistency of whitewash is a thin paste, and water will have to be added to secure this consistency after mixing the dissolved salt with the whitewash.

To each 12-quart pail of whitewash composed as above, add a good sized handful of Portland cement and a teaspoonful of ultra-marine blue. The cement and blue should be added only as the whitewash is being used, and should be thoroughly stirred into the whitewash; otherwise, when applied it will be streaked.

Where there are pipes or other equipment in rooms to be whitewashed that will rust, do not use salt in the mixture around the piping.

Do not put on too thick a coat — just enough to cover the surface in good shape —then allow from one to three days for drying. If you dry the whitewash out too quickly it will flake or brush off very easily; on the other hand, a very slow drying will allow the water to soak into the wood and may cause unpleasant odors.

Whitewash containing Portland cement must be used without delay.

OUR UNDEVELOPED WATER POWERS

WHEN the present survey of Canada's natural resources are completed under the auspices of the Canadian Pacific Railway, it will doubtless contain a great deal of new information relative to the undeveloped waterpower of Manitoba, Saskatchewan and Alberta. Investigations already made by a sub-department of the Ministry of the Interior, it is claimed, establish the fact that in the Saskatchewan River, with its tributaries furnishing the water arteries of a vast expanse of country, and in the Winnipeg River and other streams emptying into Lake Winnipeg, there is hydro-electric energy sufficient to harness 1,172,000 horse-power.

In the upper reaches of these provinces, the Athabasca, Peace and Churchill Rivers, with a number of other large streams, in their long course to the Arctic Ocean and Hudson Bay, afford new sources of energy equivalent to at least 5,500,000 horse-power. Out of this aggregate of over 1,000,000 horse-power, only a little over 100,000 has been employed. Manufacturers, it is expected, after the war, will take on new life at Calgary, within 100 miles of the Selkirk range of mountains. The Bow River, from which 31,000 horse-power has been drawn, has at least 75,000 undeveloped reserve power available for the industries of that city.

The Development and Application of Centrifugal Pumps

By H. S. Budd *

Centrifugal pumps by reason of their compactness of design, smoothness of operation, few constituent parts all of which are of comparatively simple and rugged construction, and freedom from shock and water hammer, make a powerful appeal to users of pumping machinery generally; and that their adoption to a wide range of service has in the past been productive of good results, is shown by the growing tendency to broaden their application scope still further, while intensifying their installation where already operative.

CONTRARY to the belief held by some that the centrifugal pump is a modern invention, it is in fact quite an old one and of obscure origin. One authority informs us as follows:—

FIG. 1. BELT-DRIVEN, SINGLE SUCTION, OPEN IMPELLER PUMP.

"The first pump of this kind which attracted notice was one exhibited by J. P. Appold in 1851, and its special features have been retained in the best pumps since constructed. Appold's pump raised continuously a volume of water equal to 1,400 times its own capacity per minute. It had no valve and it permitted the passage of solid bodies, such as walnuts and oranges, without obstructing its working. Its efficiency was also found to be good."

For many years the centrifugal pump was considered useful only for handling large quantities of water at low heads and was uneconomical to operate. The development of the steam engine and its application to direct acting steam pumps kept the centrifugal in the back ground where it remained almost forgotten for many years. With the introduction of electricity and motor drives and, later on, steam turbines, however, there arose a demand for a pump that could be direct driven at comparatively high speeds, and the centrifugal pump has been improved and refined to meet this requirement. This development has been along purely scientific lines with quite wonderful results, until these pumps now operate with surprisingly good performance and economy on nearly all classes of both high and low head service for which only reciprocating pumps had formerly been used.

The simplicity and compactness of construction, smoothness of operation and freedom from shock and water hammer all appeal immediately to those familiar with pumping machinery. As these units consist of but few parts, all of comparatively simple and rugged construction, with total absence of reciprocating parts, water valves, etc., they present quite a contrast to recriprocating pumps, both in attendance required and cost of repairs, and in most cases will operate with a considerable saving in power consumed.

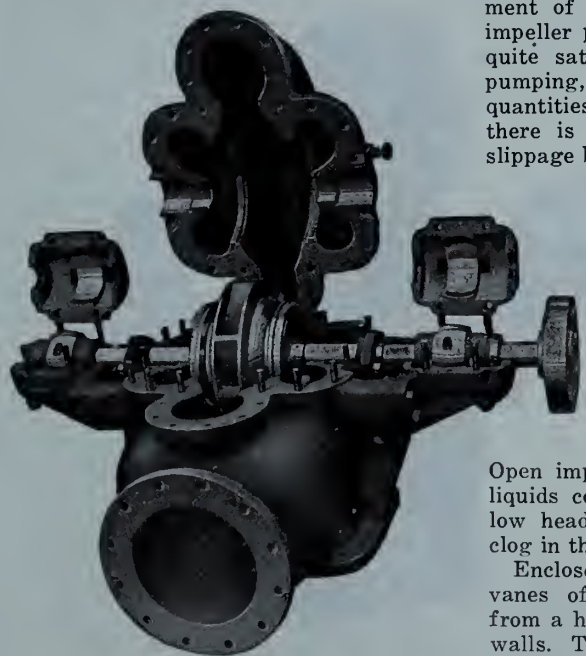


FIG. 2. DOUBLE SUCTION VOLUTE PUMP WITH CASING OPEN TO SHOW ACCESSIBILITY.

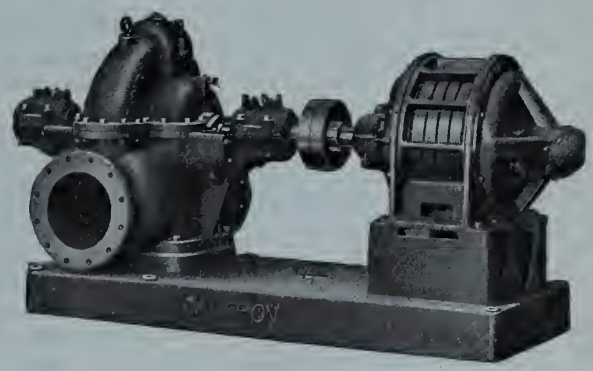


FIG. 3. MOTOR DRIVEN DOUBLE SUCTION VOLUTE PUMP.

Centrifugal Pump Types

Centrifugal pumps as built to-day are of two general classes, namely, open and enclosed impeller types, depending on the type of impeller used.

Open impellers consist of a number of arms or vanes radiating from a hub in the manner of an ordinary centrifugal blower. The sides of the vanes are usually faced off and run close to the walls of the casting on both sides in order to prevent, as far as possible, the slippage of the liquid being pumped. By refinement of design and construction, open impeller pumps have been made to show quite satisfactory results on low head pumping, especially in delivering large quantities at a head of a few feet, but there is always a large percentage of slippage between the impeller and casing, as well as excessive skin friction and internal disturbance which becomes more pronounced as the operating head is increased. These losses are variable quantities and make high efficiency impossible; the designer cannot, therefore, predict with any great degree of accuracy the ultimate performance of the pump. Open impellers are adapted to handling liquids containing some solid matter on low heads that would tend to hand or clog in the inclosed impeller types.

Enclosed impellers consist of blades or vanes of suitable currature radiating from a hub and enclosed by two discs or walls. The liquid to be pumped enters at centre or eye of the impeller around the shaft on either one or both sides, pending on whether it is of single or double suction type, and passes through the wheel in channels formed by the walls and vanes. Double suction impellers which

*Sales Engineer, the A. S. Cameron Steam Pump Works, Chicago, Ill.

are subjected to the same pressure conditions on either side, are automatically balanced against thrust along the line of the shaft for all ordinarly operating heads. Single suction impellers are not so comparatively balanced an dtherefore require end thrust bearings.

As the enclosed impeller handles the liquid being pumped through confined passages or channels of definite form with a limited amount of disturbance or leakage, a capable designer can quite accurately control the performance of the pump over a broad range of operation. For this reason the enclosed impellers are used for all medium and high head pumping equipment and when high efficiency is desirable.

Single Stage Pumps

A single stage pump contains one impeller and can be built for almost any capacity and reasonably high head with efficiency results, the larger sizes being more economical, of course, than the smaller. The greater the head created by a single impeller, the greater will be the difference in pressure between the suction and discharge chambers of the pump. This is accompanied by a greater internal slippage and leakage and more rapid destruction of the internal parts, and, therefore, is one of the factors that determine the greatest pressure or head allowable per impeller or stage.

Multi-Stage Pumps

For higher heads, multi-stage or turbine pumps are used. These consist of two or more enclosed impellers on the same shaft, running in a casing with passages so arranged as to lead the liquid through the several impellers in succession, each one adding its equal share of the total pressure desired. By this means, pressures of several hundred pounds may be obtained from a single pump, the limit depending on the mechanical limitations of design, strength of materials used and their resistance to abrasions by the liquid at high velocity. In multi-stage pumps the liquid discharged at high velocity from all, but the last impeller must be abruptly turned through 180 degs. to enter the eye of the succeeding one, and suitable vanes known as diffusers are provided to reduce the speed of this water as far as possible, and convert it into pressure as soon as it leaves the impeller, so that it may be conducted into the succeeding one with the least disturbance and impact on the walls of the casing.

All multi-stage pumps require some means of maintaining correct alignment of the rotating element with the passages in the casing and of equalizing any end thrust that may be present. In pumps handling clean fresh water, this is best accomplished by means of an internal hydraulic device in which the thrust is carried on a body of water confined by a suitable piston or diaphragm mounted on the shaft. This device is quite simple in construction, yet it automatically and promptly adjusts itself to varying load conditions, and being a water bearing with no metal to metal contact, operates with practically no loss of power. Where the liquid being pumped carries grit or solid matter that would tend to wear the parts of the hydraulic balancing device rapidly, a step bearing of the Kingsbury or marine thrust type external to the casing should be substituted.

Design and Construction

The requisites of a centrifugal pump are, first, that it shall be well and suitably constructed mechanically, and secondly, that its performance shall comply with all the service requirements and show the highest efficiency possible on that service. The pump should be of strong and substantial construction in all parts, free from vibration of the rotating elements with large and well oiled and close fitting bearings, both to insure continuous operation and to preserve the fine running clearness within the casing which serve to prevent internal leakage from the spaces of higher to lower pressures. The material of which the various parts are made should be well selected for the duty to be performed, and the general design thoroughly accessible for inspection of the interior and renewal of parts.

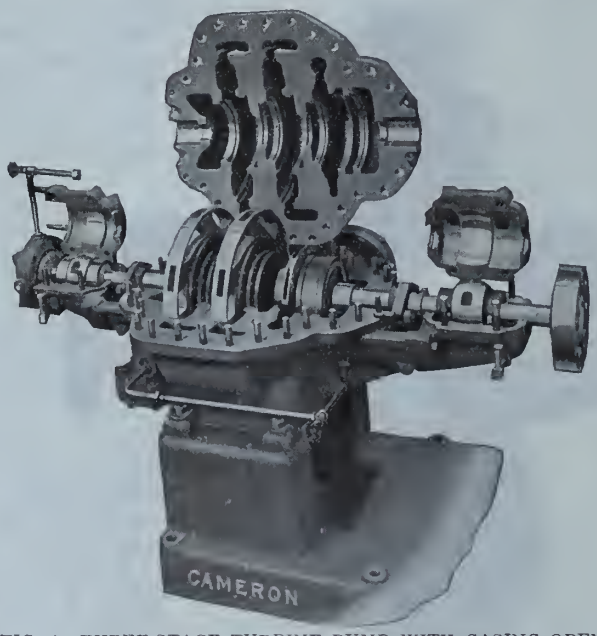


FIG. 4. THREE-STAGE TURBINE PUMP WITH CASING OPEN TO SHOW ACCESSIBILITY.

The operating principle of a centrifugal pump is quite simple. The liquid pumped is accelerated by passing it through a revolving impeller, creating both pressure and velocity, the velocity being then converted into pressure in the stationary discharge passages. However, it becomes a very complex problem to design and build a pump to deliver a given quantity of liquid against a specific head at a definite fixed speed and to accomplish same at the highest efficiency. A capable designer can predict within a small percentage of error both the performance and the brake horsepower required not only at the normal operating point, but over a range, from a condition of free discharge against no head, to a closed discharge and no liquid flowing. The solution of these problems requires a thorough knowledge of the theory of centrifugal pumps and an analysis of a very great amount of accurate data obtained experimentally from pumps of similar characteristics.

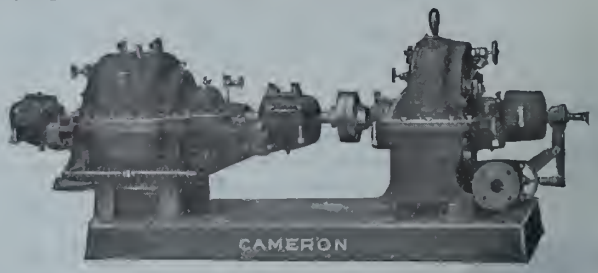


FIG. 5. STEAM TURBINE DRIVEN, THREE-STAGE TURBINE PUMP.

The production of an efficient and altogether satisfactory pump involves not only a correctly designed impeller, but the casing also must be of such mould and cross-section that changes in velocity of the liquid will take place gradually and without shock and disturbance. It requires very careful and accurate shop work to put into effect all these details so carefully worked out by the designer, in order that the finished pump may fulfill all the requirements specified, and it is, therefore, very essential that each pump be subjected to a performance test after completion, in order that any discrepancies may be detected and properly corrected. Each installation is a problem by itself and must be treated as such, if definite results and highest efficiency are to be realized.

Application and Uses

Centrifugal pumps may be driven direct or through belt or gear from electric motor, steam turbine or engine, or other source of power, as best suits the requirements of the particular installation. Direct connected to steam turbines they make highly satisfactory steam operated units. They operate on less steam and require less lubricating oil than ordinary steam pumps. They occupy small space, and their advantages in freedom from valves, valve motion, and rubbing parts are all too evident to need further comment.

Water Works Service.

Motor driven centrifugal pumps have met with great favor on water works service in small towns and villages. When operated in connection with stand pipe or

elevated tank, they may be arranged to be automatically started and stopped by means of a pressure regulator or float switch. When used with a direct pressure system, the pump or pumps may be run continuously maintaining the pressure and delivering only such water as is drawn from the mains. In localities where a part of the district supplied is on a higher elevation or some distance away requiring an excess pressure, it is found expedient to maintain a domestic pressure at the pumping station suitable for the greatest demand and to insert a centrifugal in the main that supplies the higher pressure. Such an installation is known as a booster pump and it may float on the line continuously adding a fairly constant net pressure irrespective of the amount drawn from that line. It is often the practice to use a moderate pressure in water mains for domestic service and to increase it materially in case of fire. As motor driven centrifugal pumps are preferably constant speed machines and, therefore, suitable for one pressure only, it is quite common in cases of this kind to install two or three duplicate pumps designed for domestic service and operating two in series to obtain increased pressure for fire service.

Quite a large number of turbine driven centrifugal pumps, running condensing, have been installed where in former years only crank and flywheel pumps would have been considered, and the improvement both as to reliability and economy has been so marked that at present their performance rivals the best triple expansion crank and flywheel pumping engines in total yearly operating cost, when due allowance is made for all interest and standing charges on the capital involved. These charges, of course, greatly favor the centrifugal unit on account of its comparative low first cost, together with that of the smaller building, lighter foundation, etc.

Boiler Feeding

Among the many uses of the centrifugal pump, boiler feeding is a service for which it is ideally suited. The pump is usually driven electrically or by steam turbine, whichever is best suited to the particular installation. In operation the motor-driven boiler feeder is generally allowed to run continuously at full speed, maintaining a fairly constant pressure on the feed line for a considerable range of capacity. The amount of water fed to the boiler may be controlled by a throttle valve in the feed line without danger of creating a dangerous increase in the latter, as the centrifugal will not build up a pressure exceeding 15% to 20% above normal pressure, even when the discharge is entirely closed.

Steam turbine driven boiler feeders are sometimes operated in this manner also, but they are more often equipped with pressure regulators of a type similar to those used on ordinary steam pumps to maintain a constant differential between the steam and the feed line water pressures, especially where the variation in steam pressure is considerable. Whether driven by electric motors or turbines, the feed water to the boiler can be regulated without reference to the pump, and further, there are no valves or large packings to be maintained, nor is there danger of water hammer and breakage in case of loss of suction as with reciprocating pumps.

Efficiency.

The efficiency of any centrifugal pump is highest at only one combination of head and capacity for each change of speed, and, therefore, if a pump is operated on a head or at a speed other than that for which it is designed, the amount of delivery and power required can be only approximately predicted. At the same time, the efficiency would likely be very low, making the installation quite unsatisfactory for the work it was intended to do, as well as expensive in cost of power for driving.

Low pump efficiency means increased power required, and even though it be but a few per cent. it must be borne in mind that this excess horsepower is consumed continuously while the pump is in operation and will total up to a considerable sum in a year's time, representing in dollars and cents more than the difference in cost of a well designed as against an inferior pump, or equalling the interest and depreciation on the entire installation for the same period. In like manner, the saving made by the better pump when compared with the common type, will invariably pay back its entire cost in a comparatively short time.

Wearing Parts

There are a few parts of the enclosed impeller type of pump that are subject to wear, namely, that part of the casing which makes a running joint with the impelled, and the sections of the shaft within the stuffing boxes and the bearings. If these wearing surfaces are provided with renewable parts that can be replaced at small expense, the main and more costly parts, being protected, will last almost indefinitely, ensuring a low cost of maintenance. Wearing rings secured in the casing around the impeller inlet protect the case from wear at this point, and a similar pair of rings made of bronze and secured on the impeller protect it from wear also. Bronze sleeves secured on the shaft and passing out through the stuffing boxes relieve it entirely from scoring by the jacking, or rusting. By supplying the bearings with removable ring-oiled split babbitt-lined shells of spherically seated type which may be easily slipped out when worn, and either rebabbitted or replaced by a new set, the alignment of the rotating element will not be disturbed, and the close fit between the impeller and case so necessary to prevent internal leakage, will be preserved. These features will be clearly illustrated by the views that will be shown on the screen a little later on.

Operating Conditions

It will be readily appreciated from the foregoing that in building a centrifugal pump for a particular installation, it is essential that the conditions of head, capacity and speed be accurately determined and furnished to the designer, together with any special requirements involved, especially if the highest efficiency is expected. It is not to be understood from this that the centrifugal pump is an extremely sensitive affair that will be efficient at one particular combination of head and capacity only, and of low economy when these ideal conditions do not obtain. The efficiency will remain nearly constant for a small variation in head both above and below the normal, the capacity varying inversely as the head, consequently it is usually safer to figure the total head a trifle high and design the pump accordingly, and then if the head is actually less, a slight increased capacity will result, which is not usually objectionable. Very often two or more conditions of head or capacity can be obtained from a pump of special design running at constant speed with a satisfactory balance of efficiency, and with provision for some speed variation the possibilities of designing for varying service are greatly increased.

Total Head

The total head on which a pump has to operate is made up as follows: Vertical static suction lift from the level of the liquid in the well or sump to the centre of the pump; static discharge head measured vertically from the centre of the pump to the point of discharge; friction in the piping, valves and elbows of both suction and discharge lines, velocity head, and entrance head. In addition the pump must overcome the loss of head within itself, but the builder only is concerned in this, and the efficiency of the pump is the ratio of the theoretical power required in raising the given quantity of liquid against the total head, to the sum of this power plus the hydraulic losses in the pump, and the friction in bearings and stuffing boxes. This sum is known as pump horsepower.

Effect of Speed Variation.

Both the total head and the capacity of a centrifugal pump are quite sensitive to speed variation, therefore great care must be exercised in determining the speed at which a pump is to operate in order that it may be designed accordingly. This is particularly essential when the pump is to be direct connected to a constant speed afternating current motor of which the speed at full load is several per cent. lower than at no load, and there is no convenient way of altering the speed of such a motor.

Priming

A centrifugal pump cannot raise a liquid to itself from a lower level without first being primed, because it possesses no positive displacement feature and, therefore, both the pump case and suction piping must be entirely filled before starting. Priming may be accomplished either by providing a good valve on the lower end of the suction line and filling the pump and suction piping from the discharge line or other source, or by drawing the liquid up into the pump

through the suction pipe by exhausting the air from the top of the pump case. With this latter method, the discharge must be closed off by means of a gate-valve, and the foot valve may be dispensed with if desired, provided the pump is started while it is primed. The air may be withdrawn from the pump by means of a suction pump, steam injector, or other means of creating sufficient vacuum to entirely fill the pump case.

Suction Lift.

Once in operation, a centrifugal pump will handle water or other liquid of the same specific gravity and character at ordinary temperature on as great a suction life as a reciprocating pump, namely, about 26 feet at or near sea level, and provided the suction piping and pump are entirely free from air and air leaks. Because of the difficulty sometimes encountered in maintaining air-tight suction glands and piping, 18 feet is, however, usually considered the maximum commercial suction lift, and even less is advisable whenever possible.

The limit of suction lift decreases with the rise in temperature of the liquid on account of the increased vapor tension, and it is not advisable to undertake any suction lift with water at a temperature exceeding about 150 deg. Fah., but rather have the pump so located that the water will flow into it by gravity. When handling water at or near the boiling point, as in boiler feeding, the water should flow to the pump under a head of from 6 to 10 feet, and the suction piping should be as direct as possible and of large diameter to eliminate the formation of vapor. Vapor or air or other gas in the pump in considerable quantity will collect within the suction opening of the impeller, being the point of least pressure, and impede the passage of the liquid, reducing the capacity of the pump, and at times causing it to lose its suction entirely.

Size of Piping

Bearing in mind the marked advantage of small suction lift, the intake pipe should be as short and direct as possible, with absolutely tight joints. It is usual to make the intake pipe and foot valve at least one size larger than the pump inlet to reduce friction, which, of course, adds to the suction lift. As the basic principles of the centrifugal pump require the liquid to be handled at high velocity, the suction and discharge openings are much smaller than are usual in reciprocating pumps of equal capacity, and the sizes of both the intake and discharge pipe lines should be determined from the amount of friction in the required length, which can be learned by referring to standard published friction tables.

Installation.

Centrifugal pump installations are usually provided with a gate valve in the discharge to shut the pump off from the line when not in use, or when open for inspection. There is nothing in a centrifugal to hinder the liquid flowing backward through it from the discharge line when not in operation, and consequently in cse of a sudden shutting-off of the power, the impeller acting as a water turbine, may be revolved backward at a speed dangerous to both the pump and prime mover. A foot valve on the intake pipe will prevent this occurrence, or if this is not provided, a check valve should be located in the discharge. Where the operating pressure is great and a foot valve is employed, there should also be a check in the discharge to reduce the shock on the pump case when the foot valve seats. The check valve should be provided with a by-pass in order to prime the pump should the foot valve leak.

In placing suction and discharge pipe lines they should be free from high spots or loops forming pockets in which entrained air may accumulate, as the air bubbles thus formed will offer considerable resistance to the movement of the liquid by obstructing its passage, and in case of the suction pipe they are liable to enter the pump in such quantity as to cause loss of suction entirely.

LEATHER BELTING NOTES

IN the choice of a belt, the first consideration is that it be made from a good hide. Some indicative opinion may be had by cutting a thin shaving from the samples offered, and tearing them between the fingers. This will enable even the unskilled to form an opinion as to how much of his purchase is leather, and how much simply weight-making material.

Leather belts lose a good deal of their strength and nature unless impermeated with a certain amount of oil. Good quality cod oil is largely used for this purpose. An ordinary belt thus lubricated, develops a stretching propensity, which is, of course, both troublesome and wasteful. The problem, therefore, is to secure the admittedly advantageous features of "lubrication without stretch." The solution is obvious—Stretch the belt fully before application.

The ultimate tensile strength of belting is not generally a factor in power transmission calculations. It may be reckoned at an average of, say, 3,500 pounds per square inch. Variation in ultimate strength is due not only to possible variation in the quality of the material, but to want of its homogeneity as well. The ultimate strength of a laced joint well put together should be taken at from 1,000 to 1,500 pounds per sq. inch, while that of a riveted joint may be taken as equal to one-half of the strength of the solid belt.

Adhesion of Belts

The motion transmitted by a belt is maintained solely by the frictional adhesion of the belt to the pulley rim. Belts do not communicate motion with precision on account of their liability to slip. The adhesive grip of a belt is greater on wooden than on cast iron rims.

A belt will slip just as readily on a pulley four feet in diameter as it will on a pulley two feet in diameter, provided are area of contact, the tension and the the conditions of the faces of the pulleys, number of feet the belt travels per minute, are the same in both cases. Causes of slippage are because belts are overloaded, dirty, clogged, dried up and neglected.

It stands to reason that while slip may be prevented by undue tightening, this is not the right method to make the belt do its full duty. A belt properly filled and of correct dimensions for its work, should break before slipping.

Engineers usually pay little attention to their belting except that which is giving immediate trouble. The ingredients of a leather, cotton, or camel's hair belt, Manila or hemp driving rope, slowly dry out and leave the contact surfaces hard. Unless something is added to replace these natural ingredients the belt or rope cannot be expected to grip the pulley close enough to transmit full load.

Creep of Belt

By creep of belt is meant its stretching and contracting propensity as it passes over the pulleys, and is due to inherent elasticity and nature of load. The net result is a continuous creep or shifting of the belt around the pulleys in a direction opposite to that in which the belt runs. Belt creep in practice is usually kept within a one per cent. limit, and to make certain of its attainment, the working strain for best material belt body and substantial joint is taken at 40 pounds per inch width single belt, 70 and 100 ditto for double and treble belts respectively.

When a belt runs at a high velocity, centrifugal force produces tension in addition to that existing when the belt is at rest or moving at a low velocity. This diminishes the effective driving force. Double belts are less pliable than single belts and the centrifugal force is greater. Furthermore, the tension is seldom increased proportionately; for these reasons, double belts should not be expected to transmit more than 8-5ths the power of single belts.

THE following figures give the allowable rise in temperature adopted by the British makers of electric motors as a basis of capacity rating: Open, protected, enclosed-ventilated with large mesh and pipe-ventilated with forced draught, 72 deg. Fah., for the windings and cores in which they are embedded and 99 deg. Fah. for the commutators and slip rings; enclosed-ventilated with smaller mesh, drip-proof and pipe ventilated with own draught, 85 deg. Fah. for windings and cores and 99 deg. Fah. for commutators and slip rings; enclosed-ventilated with very small mesh, totally enclosed and flame-proof, 99 deg. Fah. for windings and cores, and for commutators and slip rings, 99 deg. Fah.

Good nature will often keep a plant running smoothly and cool when good oil will not.

REFRIGERATION DEPARTMENT

DIFFERENCES IN QUALITY OF AMMONIA

By A. F. Adams.

I WAS much interested in an article on the "Differences in Quality of Ammonia," in your June issue, and was pleased to see this subject brought into print, because, I believe, as refrigerating engineers, we do not know enough about the quality of ammonia which we use. The test bottle, as has been suggested is no criterion, as to purity of the gas.

Is there not some method, whereby the engineer can test the ammonia, which he is using to his own, and his employer's satisfaction, so that both may know what they are paying for? The bottle test in the past has largely been considered all that is necessary, to determine purity, and in some cases I have seen manufacturers of ammonia, supply test bottles for this very purpose.

One phase of the subject I should like to have aired in your columns is the advisability of using different makes of ammonia in the same plant; this is sometimes found necessary.

In British Columbia I find that there are at least five different brands of ammonia, some of which it is now impossible to obtain for various reasons. A friend of mine, found it necessary to add to the charge in his plant another make of ammonia, but found that his condenser pressure had gone up about twenty lbs., where it remained for a few days, after which the pressure returned to normal.

The agent who sold the ammonia gave as a reason that his ammonia being pure drove all impurities to the condenser, and that this usually happened wherever his ammonia was used.

Upon investigation it was found that both brands of ammonia were made by the same process. Another declared that two different brands of ammonia would not mix in the system, at least for some time.

At one plant I visited they were changing to another brand. The engineer in charge told me, that he could see no difference in the working of the plant, with the exception that he was now doing more work than formerly, but as several changes had been made, he could not state whether the increased work was due to the new brand of ammonia, or to the general changes that had been made. My own experience has been similar to this. I could see no difference in the working of the machines after adding to the change from another make.

I should like someone to give us an approximate temperature at which ammonia gas will disassociate. I have been in plants where a cloud of smoke could be seen rising from the discharge pipe. Again, do we as engineers know as much as we should about the purity of ammonia gas. to be of much benefit to us, or must we consult a chemist?

INSULATION OF COLD-STORAGE BUILDINGS.

REFRIGERATING engineers have during the last few years practically discarded the empty space—the so-called dead-air space—once extensively used for insulating purposes. Theoretically, a dead-air space is a poor conductor of heat, but the ordinary air space is not a dead-air space. As one side of the space becomes warmer than the other, the air immediately in contact with it becomes lighter on account of the increase in temperature, and at once ascends, while colder air from the other side takes its place. Thus we have a circulation of air within the space, and heat is carried from one side to the other by convection. Moreover, it is extremely difficult to get the work done properly when empty spaces are depended on for insulation. The slightest crack or opening, even a nail hole, tends to destroy the efficiency of this form of construction. In the insulation of wooden walls, the best practice at the present time provides for an outer and inner shell, as nearly as practicable impervious to air and dampness, with a space between to be filled with some non-conducting material. The width of the space will depend on the filling to be used and the temperature to be maintained in the storage room.

For a cold storage constructed of wood, there is no better material for filling spaces than planing-mill shavings. Where available at all, they are cheap; they are elastic and do not settle readily; but, most important of all, they can be obtained in a very dry condition, which is essential; and further, they do not absorb moisture readily after being placed in position. There may be some difficulty in obtaining a sufficient supply of shavings in places remote from manufacturing centres, but many of the large sash and door factories now pack shavings in bales, weighing about 75 pounds each, for convenience in shipping. The weight of shavings required to fill a given space will depend somewhat on the kind of wood from which they are made, and also to some extent on how tightly they are packed, but a fair average is from 7 to 9 lbs. per cubic foot of space. They should be packed sufficiently to prevent subsequent settling.

Sawdust versus Shavings.

Because it costs little or nothing and is readily available in most country districts, there has been a tendency to use sawdust for filling spaces in walls in small cold-storage buildings. We would point out, however, that it is not as satisfactory a material for this purpose as shavings, owing to the fact that, while shavings are cut from dry lumber, sawdust is cut from green timber and is generally more or less damp. The dampness destroys its insulating value and encourages the growth of mould and rot, resulting in musty odour in the storage room, which would be injurious to the food stored therein. The growth of mold and heating would also cause settling of the sawdust and would leave open spaces which weakens the insulation. It is very important, therefore, that sawdust which is used for filling walls must be as dry as possible or the storage will be very unsatisfactory, and will soon become unfit for storing perishable foods.

Insulation Must be Dry.

One of the problems in cold storage construction is to provide against moisture being absorbed by the materials composing the insulation. In the construction of small ice cold storages, moisture or dampness is more likely to come from the inside, and provision must be made to protect the insulation. It must be understood that dampness, as referred to in this connection, does not imply the presence of water in the ordinary sense, but simply the presence of moisture as we find it, say, in green lumber, as compared with dry or well-seasoned lumber. In a wooden wall filled with shavings, it is the shavings which must be protected from dampness. This can be done by using damp-proof paper between the sheathing, or boarding, on the inside of the walls.

Brick, Stone or Concrete Walls.

If it is desired to erect a building of brick, stone or concrete, such walls will only take the place of the outside finish of wooden walls, and the same insulation must be used inside the brick, stone or concrete. None of these materials have much insulating value, and as erected in an ordinary wall are just about equal, for that purpose, to two courses of lumber. Brick or cement absorb moisture readily, and unless they are given some special water-proofing treatment, the insulating quality of such a wall is rather low. The outside surfaces of brick walls

may be painted with some effect, but where shavings are to be used inside of brick or concrete, the inner surface may be coated with pitch, paraffin wax, or some of the patented coatings on the market. Coating walls with either pitch or paraffin in cold or even cool weather without special apparatus is a rather difficult operation, on account of the tendency of both substances to harden very quickly. In using pitch, care must be taken not to get tar, or any mixture of tar, which would be ruinous on account of its odour. Pitch is odourless when it hardens. If the inside surfaces of brick or concrete walls cannot be properly waterproofed, the next best plan is to put 1-inch furring strips on the wall, then one course of matched lumber, which will form the inside surface of the space to be filled. It will be all the better if the sheathing is covered with dampproof paper.—C. G., Cold Storage Bulletin.

DANGER OF FREE AMMONIA IN BRINE TANK.

THERE are two methods by which to effectively destroy free ammonia in brine; one mechanical, the other chemical. The first is accomplished by the use of heat, and the second by employing an acid, which, by the formation of a salt, neutralizes the free ammonia.

In employing either of these two methods, one should be altogether governed by the amount of free ammonia in the brine. In the mechanical method, the use of the steam condensers has been found most effective, by pumping the brine over such. This procedure should be repeated until most of the ammonia has been driven off. A small amount left in the brine is not at all injurious.

As far as the elimination of the ammonia in the brine by chemical method is concerned, such should be left to the care of a practical chemist. By analyzing the brine, the amount of free ammonia is ascertained. By submitting size of tank and the height of the brine, the amount of brine contained therein is found. Possessing these two items, the amount of acid required for neutralization of the ammonia can be easily determined. The acid should be applied in small amounts, close to the agitator, which ought to be run at the highest possible speed, so that the distribution of the acid will be effected as quickly as possible. After 36 hours of agitation, the brine should be analyzed, and if it still contains free ammonia, additional acid must be added until the brine remains slightly alkaline.

Ice manufacturers, up to the present time, have not been on the alert as to the danger of free ammonia, to its destructive power on metal—galvanized and ungalvanized, but undoubtedly the increase in the cost of such will awaken interest in this direction.

WEAR OF TURBINE BLADING.

IN the course of a recent paper on the Deterioration of Curtis' Rateau Turbine Blading, A. Fenwick arrived at the conclusion that there is no difficulty in choosing a material for moving blades which can be depended on to give fairly satisfactory results in particular stages. Five per cent. nickel steel, brass and aluminum bronze in suitable stages will have a life of 40,000 hours, and perhaps 50,000, or more, which, if the turbines are run continuously, means five or six years. It is probable that in the majority of power stations the running hours would be much less, and the number of years the blades would last will be correspondingly increased. One has to decide what constitutes a satisfactory life, and if we assume the turbine will be in use for 15 or 20 years, the ideal blade material is one which will do its work efficiently for this period. If long life can only be achieved by the use of expensive alloys, the cost of such material would have to be compared with the saving in maintenance which would result by its use.

With regard to the life of turbine plant, one has to consider the probability of future improvements, which might increase the efficiency of turbines to such an extent that it would pay to scrap existing plants and install new ones. One has to admit, however, that a very considerable advance in efficiency would have to be made to justify this course, and the uncertainty of a sufficient improvement is a further argument for better blading material. A saving of 1 per cent. in coal consumption on a 10,000-kilowatt set supplying 6,000,000 units per month may represent about $2,000 per annum.

With regard to inlet nozzles, it is clear that no reasonable expense should be spared in making these absolutely reliable; nozzles with thin cast iron vanes should be abolished, but if cast iron is used, the design should be such that there is no possibility of pieces becoming detached.

The guide blading in use on these turbines is clearly unsatisfactory, and the reader may wonder why this state of affairs has not been remedied long ago. The user is, however, largely in the hands of the turbine builder, and, further, if a mistake has been made in design or material in the original installation, three years or more must often elapse before ths is discovered, and an equivalent time is taken to prove the success or otherwise of any alteration. Incidentally, thousands of pounds are spent by the user in large installations in renewing defective blading and making good damage caused by broken pieces, collapsed rings, etc. This maintenance should be unnecessary, and for this reason the defects have been given in considerable detail.

While the author feels that mild steel is preferable to the high percentage nickel steel in use, it must be admitted that the latter has given good results in many cases. On the fourth diaphragm J steel has been used for the 10 000 h.-p. compressors 8 and 9, and in both cases blades cracked, while on compressor 7 H steel and is in good condition.

High percentage nickel steel has been more extensively used and for a much longer period than non-nickel steel. The latter material is in use on one generator turbine, and in this case considerable pitting has occurred. The evidence obtained on a 10,000 h.-p. compressor turbine is, however, very much in favour of mild steel, and there seems little doubt that it will prove the better material. The possible causes of deterioration are not conclusive; they may all be contributory to the general failure, and the inconsistency of results, particularly at different stations, makes the whole subject very puzzling. One is inclined to blame 30 per cent. nickel steel, because so much of it is in use and fails, and it may be that mild steel will also prove unsatisfactory through cracking or pitting.

Blades made from brass sheet and carefully fitted to retaining rings have been used for small turbines by some manufacturers, and various methods of attaching blades could be devised. The cast-in method used on the turbines described in this paper is, however, very simple and requires a minimum amount of machining and fitting, so that it would be preferable to retain this design if satisfactory results can be obtained.

The author believes that the position can be much improved by the use of thicker blades of mild or low percentage nickel steel, say, ⅜-in., or ¼-in. tapered, perhaps, on the outlet side to ⅛-in. Unfortunately, an alteration of this kind on a ring designed for 2 mm. blades reduces the area for steam passage somewhat. To obtain the same port area, the radial length of the guide blade would have to be greater, necessitating a longer moving blade.

BRITAIN'S MUNITIONS SUPPLY

IN the course of a review of the work of the Ministry of Munitions by Dr. Addison in the House of Commons, July 28, it was stated in regard to explosives that the capacity was now four times that of a year ago, and twenty-eight times that of March 1915. The shell supply, both in quantity and quality was adequate—in spite of the enormous expenditure during the last few weeks the stock of filled shell had only been reduced seven per cent., and premature bursts were almost negligible. "Tanks" of various types were under constant construction and development, and motor transport facilities were so great now that considerable help was being extended to the Allies in this respect.

Overseas munitions supplies had been received with gratifying regularity, losses due to submarine activities being only 5.9 per cent. of consignments.

Yearly steel production in Britain is expected to reach 12,000,000 tons by next March—it is now 10,000,000 tons as against 7,000,000 tons three years ago. An interesting point in this respect was the expected increase of 1¾ million tons due to the utilization of home ores in the making of basic steel. Gun ammunition costs had been reduced so as to effect of saving of over $200,000,000 on the year's bill for these supplies alone.

Association and Personal

CANADIAN ASSOCIATION OF STATIONARY ENGINEERS' CONVENTION AND EXHIBITION

THE 28th annual convention of the Canadian Association of Stationary Engineers, held at Toronto on July 24, 25, 26 and 27, was up to the high standard of previous gatherings, both as regards the business transacted at sessions of delegates and the exhibit of power equipment and supplies. In the exhibition hall, about fifty manufacturers occupied booths. The C. A. S. E. have recently secured a Dominion Charter and will thus be enabled to extend the scope of its activities. The executive are endevavouring to arrange for provincial reciprocity in licenses, and it is hoped that enactment of graded certificates for the Province of Ontario will become effective during 1918. Legislation to this end has been inaugurated. The convention next year will be held at London, Ont.

The executive officers of the Association met in the Prince George Hotel, Toronto, on the evening preceding the Convention opening, treasurer A. W. Heath being the only absentee, through illness. On this occasion, committees were appointed as follows:—

Credential—D. W. Laver, C. Hooper, J. Ogle.

Mileage and per Diem—Messrs. Laver, Hooper and Ogle.

Good of the Order—W. H. Johnston, W. A. Sweet, J. W. McGrath, S. Balmfirth, T. J. Tait, J. F. Smith, R. Walker, R. McCrudden, Geo. Moll.

Ways and Means—E. R. Grandbois, D. Freedy, Jno. Brown, C. Ott, R. S. Wright.

Auditors—R. D. Smith, S. E. Cosford.

Convention and Exhibition Opening.

Due to the unavoidable absence of Mayor Church, it fell to the lot of C. A. S. E. Executive President Forbes and Earl F. Hetherington, president of the Exhibitors' Association, to welcome to Toronto the delegates, their ladies, and others interested in the welfare and objects embraced in the activities of both organizations. Messrs. Wickens (Dad) Keith, Peiler, McGhie, and Crouch also took a hand in the inauguration ceremony, which was brought to a close by the singing of the National Anthem.

At the opening session of the Convention, the President's address naturally came first, its outstanding features emphasizing the necessity for immediate enactment of a scheme of graded certificates for engineers and the establishment of provincial reciprocity relative to same. The recent Bill of Incorporation secured by the Association was also discussed. The minutes of last year's Convention at Montreal having been read, as also the reports of the Secretary and Treasurer, each of which were of a highly satisfactory nature and reflected creditably on the energies and activities of Messrs. Hale and Heath, the various committees went about their allotted work, which consumed the whole afternoon.

ENGINEERS' BOOT AND SHOE RACE, HAMILTON No. 2, C.A.S.E. PICNIC.

OPERATOR ORGANIZATIONS

British Columbia Association of Stationary Engineers, Vancouver.—Subordinate Lodges at Vancouver, Victoria, New Westminster, Cumberland, Merritt, and Fernie.

North-West Association of Stationary Engineers, Edmonton, Alta.

Manitoba Association of Stationary Engineers, Winnipeg.

Canadian Association of Stationary Engineers, Hamilton, Ont.—Subordinate Lodges at Montreal, Toronto, Hamilton, Ottawa, Brantford, Guelph, Kitchener, Chatham, Ont.; St. John, N.B.; Owen Sound, London, Stratford, Belleville, Kingston, Sudbury, St. Thomas, North Bay, Port Arthur, Sarnia, and Windsor, Ont. The executive officers of the C.A.S.E. Grand Lodge are as follows:—

Past President.—Robert Dyson, Guelph, Ont.

President.—W. G. Forbes, Montreal, Que.

Vice-President.—Rodger F. Gofton, Kitchener, Ont.

Treasurer.—A. W. Heath, Hamilton, Ont.

Conductor.—William Cooke, Belleville, Ont.

Doorkeeper.—John W. Beasley, Chatham, Ont.

Secretary.—John H. Hale, Hamilton, Ont.

At the delegate sessions on Thursday, London, Ont., was given the honour of having next year's Convention, although Kitchener, Ont., gave the boosters for London a close run for it. Election of officers resulted as follows:—

Past president, W. G. Forbes, Montreal; president, R. F. Gofton, Kitchener; vice-president, W. Cooke, Belleville; secretary, J. H. Hale, Hamilton; treasurer, A. W. Heath, Hamilton; doorkeeper, Geo. Moll, London; conductor, S. Balmfirth, Toronto.

Past President Dyson installed the new officers, while Past President E. R. Grandbois acted as Grand Tyler. Presentations of jewels were made to Past President Forbes and Secretary Hale, the latter receiving two extra bars to his jewel and an increase of salary, as a mark of the Association's appreciation of his services during the past year, especially in developing and carrying through the Bill of Incorporation. A. M. Wickens made the presentations. Following the foregoing ceremonies, papers of an educational nature were read by Messrs. Forbes, Hale and Valiquet, of the Quebec Engineers' Examining Board.

The lady visitors were cared for during Convention week by Messrs. Williamson and Wickens. Aside from the trip to Niagara Falls, automobile rides, theatre parties, candy and ice cream treats were the specialties indulged in and enjoyed by them.

Entertainment Features

A well arranged entertainment programme provided a welcome relaxation from the business end of the convention, while the fine weather added materially to the success of this feature. The proximity of Niagara Falls to Toronto was taken advantage of and a most enjoyable day was spent there on the Wednesday. The party, which numbered about 180, embarked on the Cayuga at 7.30 a.m., and after a pleasant sail arrived at Lewiston, N.Y., where electric cars were taken to the Falls via the Gorge Route. The scenic beauty of this popular route was most impressive, particularly to those who had not been that way before. Upon arriving at Niagara Falls, N.Y., the party was taken in hand by William Adelbott, chief engineer of the Shredded Wheat Co., and a move made to the factory, where an excellent lunch was served. While in Niagara Falls, N.Y., the C. A. S. E. were the guests of the National Association of Stationary Engineers, who accorded the visiting party

a hearty welcome and left nothing undone to make the outing both pleasant and interesting.

At the conclusion of lunch, it had been arranged to inspect the factory, but as noon hour intervened, this part of the programme was deferred until later in the day. After a brief rest in the commodious reception rooms, a move was made to the Falls, and, in spite of the heat, few absentees were noticeable. At this point, the party scattered and went their devious ways. A considerable number, however, during the afternoon, returned to the Shredded Wheat plant and were conducted through same to witness the various stages of manufacture of shredded wheat. This was in many respects the most interesting feature of the trip and everyone was impressed by the air of cleanliness prevailing throughout. The Shredded Wheat Co. maintain a regular staff of guides for showing visitors round the plant, the latter being always welcome.

Owing to the great heat prevailing, much of the spare time was spent in an endeavor to keep cool, some making for the nearest shade trees, while others preferred the invigorating atmosphere surrounding electric fans. The return was made via Niagara Falls, Ont., or the Gorge Route, according to individual inclination; a few, however, did the thing in style in automobiles. The return trip across the lake was made on the Cayuga, leaving Queenston at 7.15 and Lewiston at 7.45 p.m. Although the boat was crowded, the party made merry, the proceedings being enlivened by an impromptu concert. Toronto was reached at 10.30 p.m. The weather was perfect and the trip was thoroughly enjoyed by everybody.

On Tuesday evening a smoking concert was held in the Victoria Hall,. Toronto, and, judging by the applause, the efforts of the entertainers were much appreciated. The principal items on the programme were a boxing bout by the Baker Bros.; music and songs by Jules Brazil; solos by James E. Fiddes and G. E. Cole; while Jack Armour's monologues were as usual very entertaining and mirth provoking.

An item not on the programme was pulled off at noon on Tuesday at the conclusion of the morning session of the Exhibition Committee. H. S. Stephens was presented with an umbrella and a framed photograph of the Exhibitors' Association officers as a slight token of appreciation for the assistance he has rendered at various times to the enterprise. L. H. Rummage was also presented with a framed photograph of the officers. The presentations were made by Jack Armour.

Exhibitors' Association Officers, 1917-1918

The exhibitors, at a meeting held on the Thursday morning, elected the following officers for the ensuing year:—

Past president, Earl F. Hetherington, Goldie & McCulloch Co., Galt, Ont.

President, Flight-Lieut. Lloyd Archibald, on active service with the R. F. C.

1st vice-President, C. W. Schrag, Bawden Pump Co., Toronto.

2nd vice-president, T. S. Mock, Jenkins Bros.

Secretary, Gordon C. Keith, "Canadian Manufacturer," Toronto.

Assistant secretary, L. H. Rummage, V. B. Anderson Co., Cleveland, Ohio.

Treasurer, B. G. Newton, "Power House," Toronto.

Chairman, Exhibition Committee, A. Betton, Jas. Morrison Brass Mfg. Co., Toronto.

Chairman, Entertainment Committee, H. J. Ramshaw, Mgr. Garlock Packing Co., Hamilton, Ont.

WHEELBARROW RACE. HAMILTON No. 2, C.A.S.E. PICNIC.

Exhibitors, Representatives and Exhibits

Geo. W. Cole, Ltd., Toronto, represented by G. W. Cole and G. E. Cole—Cole return trap system draining two low pressure radiators, lifting and boiler feed traps.

Boiler Repair & Grate Bar Co., Toronto, represented by A. Hett and C. W. Andrews—20th Century dumping and shaking grate.

Dart Union Co., Toronto, represented by J. B. Goff and James Rae—Dart unions.

Bawden Pump Co., Toronto, represented by C. N. Schrag and T. Jones—1,000-gallon stock pump and combined motor-driven condensate pump.

Allen General Supplies, Ltd., Toronto, represented by E. D. Wilkes, E. W. Nick and A. W. S. Roberts—Venturi meter recording apparatus. Northern Equipment Co. lines, "Copes" feed water control.

V. D. Anderson Co., Cleveland, represented by L. H. Rumage—Steam traps and other power specialities.

Canadian Powers Regulator Co., Toronto, represented by C. B. Owens and T. C. Brooker—Automatic temperature regulation.

Canadian Fairbanks-Morse Co., Montreal and Toronto, represented by P. E. Thring and G. Janes — Durabia, Palmetto and Manhattan packings, Pratt & Cady valves, "Foster" reducing valves, "Strong" traps, S K F ball bearings.

A. F. Bowser Co., Toronto, represented by T. H. Rhodes—Oil storage and filtration systems.

Canadian Allis-Chalmers, Ltd., Toronto, represented by W. H. Burbidge—"Squires" trap, literature covering Harrison Safety Boiler Works apparatus and illuminated interior factory views.

Canuck Supply Co., Montreal, represented by J. G. Dohn—Anchor packings, "Bruebacker" taps, dies and reamers, "Vim" packings and belting. W. S. metallic packing, railway supplies.

Garlock Packing Co., Hamilton, Ont., represented by N. A. Davis and H. J. Ramshaw—Garlock high-pressure and sheet packings, gaskets, pump valves. Model engine operating on compressed air, demonstrating packings.

Darling Bros., Montreal, represented by J. H. Wiseman—"Dexter" valve reseating machines, "Webster" heating systems, "Sylphon" traps, "Burnham" pumps, "Union" air-cooled air compressor, reducing and back-pressure valves, "Clarke" flexible couplings.

Dominion Belting Co., Hamilton, Ont., represented by J. Scott—"Maple Leaf" stitched cotton and duck beltings, belt dressings.

Goldie & McCulloch Co., Galt, Ont., represented by E. F. Hetherington—Photographs and literature, descriptive of engine and boiler installations.

The Canadian Manufacturer, Toronto, represented by G. C. Keith and C. A. Brandt.

Dearborn Chemical Co., Toronto, represented by J. L. Beebe, A. W. Crouch and J. Thompson—Boiler-feed water treatment.

Federal Engineering Co., Toronto, represented by G. H. Mowers—Samples of "Scandinavia," "Lanco," "Federal" and "Balata" beltings.

John W. Gates, Montreal—Boiler furnace blocks, fire brick arch.

James Morrison Mfg. Co., Toronto, represented by A. Betton—Extensive display of steam brass goods, valves, gauges, lubricators, injectors, whistles, engine-room telegraphs, etc.

France Packing Co., Tacony, Pa., represented by A. F. France—France metallic packings.

Jenkins Bros., Montreal, represented by Jas. S. Mock—Line of brass and iron body globe and gate valves.

Mason Regulator & Engineering Co., Montreal and Toronto, represented by H. L. Peiler, John Collins and E. T. Jeffrey—"Bundy" traps, "Ashton" and "Mason" valves, "Simms" heaters, Griscom-Russell Co. products, "Everlasting" blow-off valves, "Babbitt" adjustable sprocket wheel, venetian-blind grate, master steam gauge, etc.

Lunkenheimer Co., Cincinnati, Ohio,

represented by E. A. Wilkinson—Valves and lubricators.

Keystone Lubricating Co., Philadelphia, Pa., represented by H. W. Allen—Keystone greases.

Quaker City Rubber Co., Philadelphia, represented by G. M. Wilkinson—P.P.P. rod packings, "Eborite" sheet and stop valve packings, mechanical rubber goods.

C. B. Turner, Toronto, represented by C. B. Turner and J. Liston—Smoke abater, plastic boiler and furnace linings, boiler skimmer.

"**Power House**," Toronto, represented by B. G. Newton, A. G. Webster and M. H. Woods.

"**Power**," New York, represented by Jack Armour.

Lyman Tube & Supply Co., Montreal, represented by J. A. Fitzgerald—Golden glow headlight, "Baldwin" chains and sprockets, "Cyclone" chain hoists and trolleys, "Shelby" cold-drawn seamless steel tubings, "New Departure" ball bearings, "Nice" thrust collars, "Roundbrook" bushings, "Garton-Daniels" lightning arresters, "Lyman" metallic packing and elevator guide lubricators, etc.

Shell Bar Boico Supply Co., Toronto, represented by H. A. Stephens—Anticlinker grate bar, "Boico" boiler compound, "Fit it" welding compound for high-speed tool steel.

HAMILTON NO 2 C. A. S. E. ANNUAL PICNIC.

HAMILTON NO 2., Canadian Association of Stationary Engineers, held its annual basket picnic at Dundurn Park, the Ambitious City, on Saturday, Aug. 4. Ideal weather favored the afternoon's outing, and contributed materially to the otherwise enjoyable entertainment which the lodge executive had planned for those present. A program of sports was arranged, for which useful prizes were donated, and needless to say, the different events were enthusiastically entered into and keenly contested. Representative engineers were present from London, Stratford, Kitchener, Toronto, Galt, etc., on invitation of the Hamilton Lodge, and no doubt, all of them went away impressed with the idea that whatever other claims Hamilton No. 2 has to go-aheadness in matters pertaining to the craft welfare, and they are not few, for sociability and get-togetherness, she sets an example worth emulating. All of the "boys" were not able to be present, as was to be expected, otherwise all Hamilton must needs go on holiday, and of course, as fate would have it, Jack Hale, the popular Executive Secretary, was among those who perforce had to keep the "home fires burning."

Donors of Prizes

Waterous Engine Co. Brantford, Power House of Toronto, Ontario Lubricating Co., Imperial Oil Co., Anderson Trap Co., U.S.A., Gillies Guy, John C. Diggins, Canadian Fairbanks Co., Mills Hardware, J. Hodgson, Gordon Thomson, Armour & Co., Rae Bros., Machinists; Boston Isulated Wire Co., Smart-Turner Co., Wood Vallance & Co., Alexander Hardware, Westinghouse Co., John Duff & Sons, Dougal Turner, Abso Pure Ice Co., Crown Oil Co., Green's Fuurniture Co., Kellog Oil Co., Gordon McLaren, Crescent Oil Co., H. O. Food Co., Tuckett Tobacco Co., Hamilton Dairy Co., Bros. Sweet. Laver, Jones, Cosford, S. Burgess, Hale, P. Burgess, of Hamilton No. 2, Woodward Chemical Co., Goldie, McCulloch of Galt, C. B. Turner of Toronto, Chas. Kelly, Canadian Casuality Boiler Insurance Co.

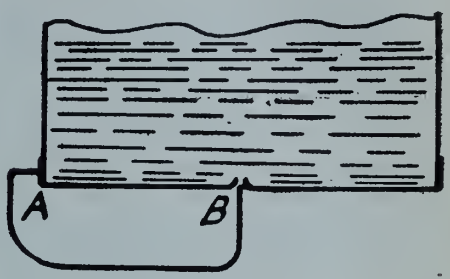
If advice had a market value, how the list of millionaires would grow!

THREAD THE NEEDLE RACE, HAMILTON No. 2. C.A.S.E. PICNIC.

COOLING A TROUBLESOME BEARING

By J. E. McC.

TO aid in keeping a troublesome bearing cool, the oil recesses were capped with a tin cover, and a tomato can with a small hole punched in the centre of its bottom was suspended above the bearing and kept supplied with cold water. A small piece of waste placed on the tin cover was used for the water to drip onto, and from thence flow in different directions, instead of falling on the bare metal and flowing off in a single stream; too much waste is not advisable, as it was found that this would often prevent surface radiation from the metal and do more harm than good. The water kept the bearing cool enough for continuous operation, and having the hole in the centre



COOLING A TROUBLESOME BEARING.

of the can neutralized all rotary motion of the latter as its suspending cord twisted and untwisted with the changing weight. To open the hole if it became clogged, a wire was bent, as shown in the sketch. The distance from A to B was equal to the radius of the bottom of the can; therefore, with A placed against the side of the can at its bottom edge, the point B had only to swing to find the hole in the centre of same.

THE ELECTRIC TRUCK

IT IS STATED that the total value of electric trucks in the United States is approximately $36,000,000. If the same ratio in proportion to the population were obtained, Canada should possess electric trucks to the value of about $3,000,000. Information at hand shows that the total investment in electric trucks in the Dominion of Canada very likely does not exceed $300,000. From the above we can conclude that the field in Canada for the sale of electric trucks is very fertile and offers great possibilities either to the manufacturer or central station that is willing to put forth the proper amount of effort, says the report of the Canadian Electrical Association.

The principal reasons for the rapid success of the electric truck are the low up-keep and reliability. Supplementary reasons are the improvements in charging apparatus, the development of charging stations equipped with proper facilities, together with the increased capacity of storage batteries. In this connection it is interesting to note that the storage battery, as manufactured at present, possesses an average life of double that of a few years ago.

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Vol. X. AUGUST, 1917 No. 8

PRINCIPAL CONTENTS

Mechanical and Electrical Equipment of a Modern Hotel.....221-224

Test Data Relative to Uniflow Steam Traction Engines.....225-229

General 229-230
Loco. Boiler Explosion....Coal vs. Wood Fuel....Our Undeveloped Water Powers.

The Development and Application of Centrifugal Pumps.....231-234

General 234
Leather Belting Notes.

Refrigeration 235-236
Differences in Quality of Ammonia....Insulation of Cold Storage Buildings....Danger of Free Ammonia in Brine Tank.

General 236
Wear of Turbine Blading....Britain's Munitions Supply.

Association and Personal 237-239
Canadian Association of Stationary Engineers' Convention and Exhibition....Hamilton No. 2 C.A.S.E. Annual Picnic.

Editorial 240
Develop Our Water Powers to Save Coal....Avoid Waste ....Exercising the Mental Faculties.

The Operators' Point of View 241-244
Shaft Diameters of High Speed Engines .... Interesting Reversing Gear....Making Thermometer Register Correctly ....Flow of Steam Through a Given Orifice .... Simple Boiler Compound Feeder....A Tin Candlestick....Briquetted Coal and Coke....Inexpensive Oil Filter....Trap for Steam Pressure Gauge....Installing Grease Traps for Separator Drips....Stropping a Razor.

Operators' Instruction Course 245-246
Education Paper—II....Readers' Queries and Answers.

General 246
Rope Driving.

Steam Power Plant Auxiliaries 247-248
Feed Pump Governors.

Projects and Developments 249
Trade Gossip....Catalogues.

Progress in New Equipment 250
New Types of Oil Circuit Breakers....Michell Thrust Bearings....A Remarkable Oil Engine....Automatic Starters for Induction Motors.

EXERCISING THE MENTAL FACULTIES.

HOW many workmen in the industrial world realize the loss they sustain by failing to make the most of the opportunities that each day has to offer. The vast majority of employees are apparently satisfied to "put in the time" at their daily task without much more than a passing thought as to the "why" or the "how" of its accomplishment. The successful achievement of one's duties is an essential factor in the solution of life's problem, nevertheless, it is equally if not more important that the full faculties of the mind be employed as a co-worker with, and a silent advisor of the eyes, ears and hands, to insure increased confidence in future effort.

Physical achievement unaccompanied by mental effort is but so much waste of energy. Thinking of one's work is necessary if the man is to become the master. The reasoning powers of the individual deteriorate more from disuse than overuse. Machinery that is constantly neglected will be ruined more rapidly than that in continual operation.

AVOID WASTE.

THE world war has taken so many producers from the sources of food supply that the world's consumption of food is greater than the amount available, and consequently, food reserves are being rapidly depleted. Millions of men are actively engaged in warfare and in the supply of munitions and equipment. They are fighting our battles and we must provide their food. Canada will produce all the food we can consume, but Canadians have never been known as a selfish race. Our Allies, therefore, are depending upon us for help and our people will unquestionably respond with generous hand.

Sir Robert Borden has said that Canada is in the war "to the last man and the last dollar." Canada is also in the war to the last pound of food. Canadians are their brothers' keepers, and will feed them, cost what it may. It is necessary, therefore, that we practise economy of the food supply. It is better to deny ourselves from choice than from necessity.

DEVELOP OUR WATER POWERS TO SAVE COAL

CANADA depends upon the United States for a large portion of her coal supply both for domestic and industrial purposes; she is therefore much interested in the coal conditions obtaining there. A recent communication from Secretary F. K. Lane, of the U.S. Dept. of the Interior shows how acute the situation has been made by the entrance of our neighbors into the war. One of the remedies urged, particularly applicable to Canada, is the immediate conservation of fuel by the efficient use of all available water power. Elimination of unnecessary consumption of coal is considered a problem of national interest and of immediate concern.

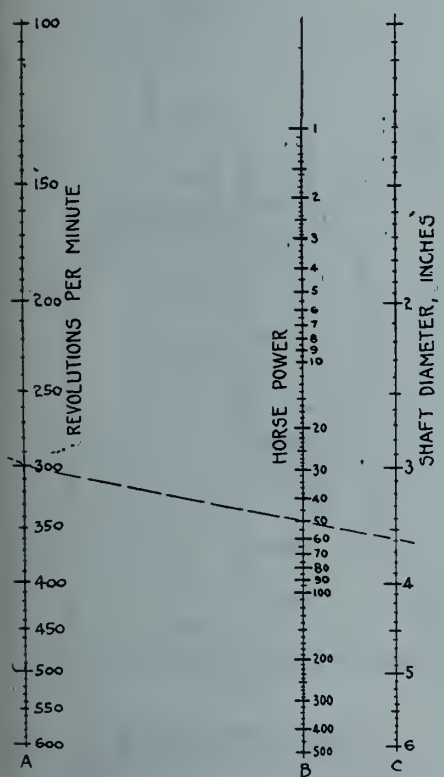
New power requirements should therefore be met, so far as practicable by utilization of hydro-electric energy; this would also apply to present steam generating energy consuming coal or oil in its production. Thus, all water available at water power plants should be utilized to produce energy up to the capacity of the works and the requirements of the population and industries within transmission distance of the site; every facility should also be given for the efficient development of new sites. In regions where water power can be made available, steam power plants should be operated only to carry loads in excess of those that can be carried by water power plants. The adoption of this course, in many cases, would mean cheaper operation, particularly in view of the rapidly increasing price of coal.

The Operators' Point of View

SHAFT DIAMETERS OF HIGH SPEED ENGINES.

By N. G. Near.

A RATHER peculiar thing about steam engines is the varying designs and sizes adopted by the different manufacturers. One manufacturer will use a 3½ inch shaft for a 50 h.p. engine running 300 r.p.m., whereas another manufacturer will use a 4 inch shaft at the same speed. There is no good reason why there should be this difference in size, aside from the fact



HIGH-SPEED ENGINE SHAFT DIAMETER CHART.

that one might prefer to use a greater factor of safety than the other. Since the cost of an engine is proportional to the weight, it is evident that the engine having the larger shaft is liable to weigh more than the engine having the lighter shaft and as a result the maker of the light engine can undersell the maker of the other. Inasmuch as both these engines give good dependable service when in actual use, however, it is difficult to tell which engine is "best." Perhaps the heavier engine will last longer, and perhaps not, in spite of its higher cost.

O. N. Trooien of the University of Wisconsin has studied steam engine design pretty thoroughly and has tabulated most of the common dimensions used in current steam engine design. Based on these tabulations he has developed curves or formulas which represent the average practice. It is allowable for us to use curves and formulas of this kind because we can rest assured that they will "work." They will give us engines and parts of engines that will be heavier than the lightest, and lighter than the heaviest. Mr. Trooien's study covered the best known engines only—not those that give trouble or are doomed to failure. As a result of this investigation, an "average" formula was developed for the shaft diameter of high speed centre crank engines. This is the formula:

$$d = 6.6 \sqrt[3]{(h.p. \div N)}$$

where d = diameter of the shaft in in.
h.p=the horse power of the engine
N=the revolutions per min. on the shaft.

Based on this formula, I have developed the chart herewith which will be found handy for determining any shaft diameter for any ordinary high speed engine. All that is necessary is to lay a straight-edge across as indicated by the dotted line drawn across the chart and the intersection with the "unknown column" gives the desired result. For exampe: What should be the diameter of a shaft for a 50 h.p. engine whose speed is 300 r.p.m.?

Connect the 300 (column A), with the 50 (column B), and continue the line until it cuts column C. The intersection with column C shows that the shaft diameter should be 3.6 inches. Should it be desired to make the diameter larger, of course, that could be done, at the same time, it would not be good policy to make the diameter smaller.

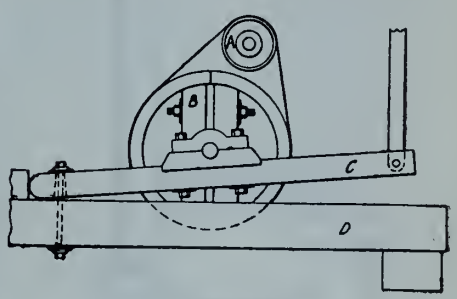
The chart will also be found useful for determining the safe load that can be imposed on your engine. Let us suppose, for instance, that the shaft in your engine is larger than necessary for carrying normal load, and this you can easily find out by using this chart. Thus if your shaft diameter is 3.6 inches, whereas it should be only 3 inches according to this chart, it is evident that little danger will result from increasing the pressure on the piston as far as the shaft itself is concerned. To be sure the other parts of the engine must be considered also before increasing the pressure or endeavoring to make a high-powered engine of it. One must be careful of the piston rod, the keys, the cylinder walls themselves, the head and crank end of the cylinder, etc. Every part that will be subjected to a greater stress must be given a proper examination and reckoning.

The range of this chart, it will be noted, is wide enough to care for almost any high speed engine, delivering all the way from 1 to 500 h.p. and covering all speeds from 100 to 600 r.p.m. It is very seldom that we see an engine with a shaft smaller than 1 inch or larger than 6 inches, and that is why, altogether, the chart can be considered complete and should be handy to keep on tap by engineers, students, designers, etc.

INTERESTING REVERSING GEAR

By J. Haliburton.

HAVING occasion to erect a certain mechanism in which the main shaft could be driven in either direction at will, and figuring that the probable outlay, to-



INTERESTING REVERSING GEAR.

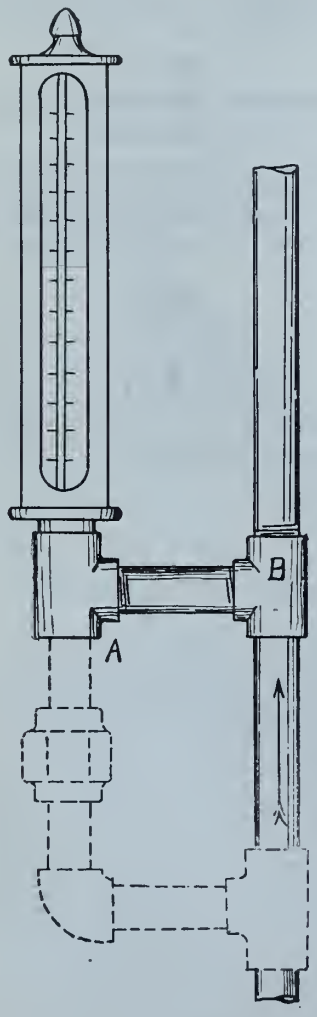
gether with the space required for reverse gears and clutches, and friction wheel trains, would entail prohibitive expense, the contrivance shown in the accompanying sketch was designed and constructed with very satisfactory results. The sketch A represents a gasoline engine pulley, while B is a wooden pulley used as a friction wheel when reversing, and as a belt pulley in the forward motion; one of the sills on which the machinery is supported is shown at D, while the beam C carries the end bracket of the driving shaft. The outer end of the beam C is connected to the operating lever by the link shown, the lever being in a horizontal position. With C raised, reverse motion is obtained, the

belt hanging by its own weight on the engine pulley A. When C is lowered, the weight of the shaft and pulley comes upon the belt, and forward or driving motion is obtained. The machinery is only loaded on the forward motion, so that the variation in the shaft alignment necessitated by the reversing operation is not sufficient to materially affect the working conditions. The length of the present shaft is about 5 feet, but a longer one could be used if aligning trouble should develop. By having the axis of B to one side of A, greater friction is obtained between the two pulleys when working in the reverse position. A suitable notch is provided to retain the mechanism in a neutral position when so desired. When operating in the reverse, and also during the accelerating period of the forward movement, a guide is necessary to keep the belt on the engine pulley. This arrangement has given very efficient service, and is as easily controlled as with a friction wheel train.

MAKING THERMOMETER REGISTER CORRECTLY

By K. Noble.

A THERMOMETER connected on a hot water pipe did not register correctly. It was connected as shown in sketch, a plug being in the end of the tee at A.



MAKING THERMOMETER REGISTER CORRECTLY.

The plug was removed and a pipe connected as shown by the dotted lines and everything was O.K. The flow of the hot water is shown by the arrows. Of course an angle end thermometer could have been secured and connected into tee B. However this would have partly obstructed the upright, but even if this would make no difference it cost less to make the change than it would to buy another thermometer.

FLOW OF STEAM THROUGH A GIVEN ORIFICE.

By N. G. Near.

NAPIER'S formula is well known the world over in engineering circles as a "pretty good one" for determining the flow of steam through an opening into the atmosphere. It may be applied nicely to finding the weight of steam used by a steam jet blower such as is often used for inducing draft in the chimney or for forcing air through the grates directly. In other words, where the drop in pressure is great, Napier's rule is excellent.

I have often related my experience with Napier's formula, which is sometimes doubted; but it is absolute truth. I measured the diameter of an orifice to to the hundredth of an inch by simply applying this rule, and I had never so much as seen the orifice until after my computations were all made. I weighed the water condensation from the steam that passed through the orifice and then determined the diameter of the orifice "backwards". The diameter was 0.16 of an inch. This is the formula

$$W = \frac{P\,A}{70}$$

, where W=the weight of steam passing through the orifice per second in pounds.

P=the absolute steam pressure in pounds per square inch.

A=the area of the orifice in square inches.

It is therefore evident that it wasn't much of a trick to use the formula backwards after knowing P and W.

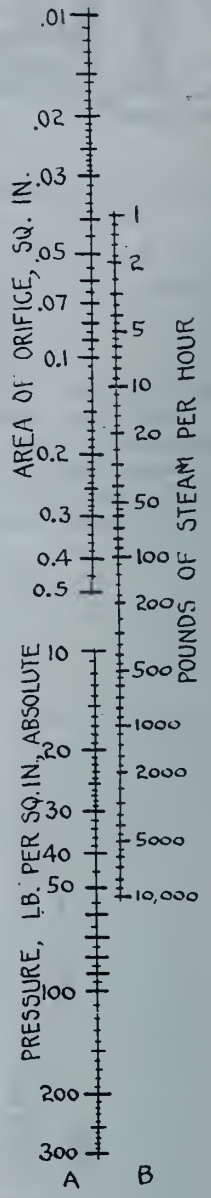
This little chart is based on that formula. It gives the weight of steam flowing through the orifice per hour instead of per second (see column B.).

To show how the chart is used let us take an example:—"Where the area of the orifice is .07 sq. in. and the steam pressure is 100 lb. per sq. in., how many pounds of steam flow through per hour?

Find the .07 in column A and the 100, also in column A. Then find the point midway these two figures. Directly opposite the mid-point is the answer, 360 pounds per hour.

It is a simple matter to find the mid-point. If you have a slip of paper handy just lay it alongside the scale and double it between the two points. Get the idea? The mid-point is at the crease, exactly. You can't beat the method with the finest pair of proportional dividers made. Of course, if you have a pair of dividers handy, use them, or use a ruler. There are many ways in which a line can be bisected but some of them are easier than others. What we all want, always, is the easiest way.

Again, should it be desired to find the area of orifice necessary to carry away 360 pounds of steam per hour with a



FLOW OF STEAM THROUGH A GIVEN ORIFICE.

steam pressure of 100 lb. per sq. in., you would go at it in the "opposite" manner. Find the distance from the 100 (column A) to the 360 (column B), and then measure upward that self-same distance from the 360. The answer, of course, is .07 sq. inches, pound in column A.

Another application of this rule or chart is to the soot blower. It will tell at a glance the weight of steam used per hour in blowing soot. From the result one can easily compute the cost of steam for soot blowing. That is a subject that has scarcely been discussed, if at all. Have you ever thought of it? Why not use the chart or formula once in a while, here and there, and determine a few of your costs? Maybe they are more than

you have estimated off-hand and maybe they are less.

Further, maybe you have a lot of leaky pipes in the plant. Maybe you have some cracked valves here and there which are purposely cracked to carry away the condensed steam. Maybe you feel that cracked valves are cheaper than a good steam trap. There are hundreds of ways, almost, which this chart can be used in and around a steam plant. Steam is expensive these days. It is growing more expensive right along. It should therefore be studied a bit more carefully. No harm can result from knowing the aproximate cost of every little operation where steam is used.

SIMPLE BOILER COMPOUND FEEDER

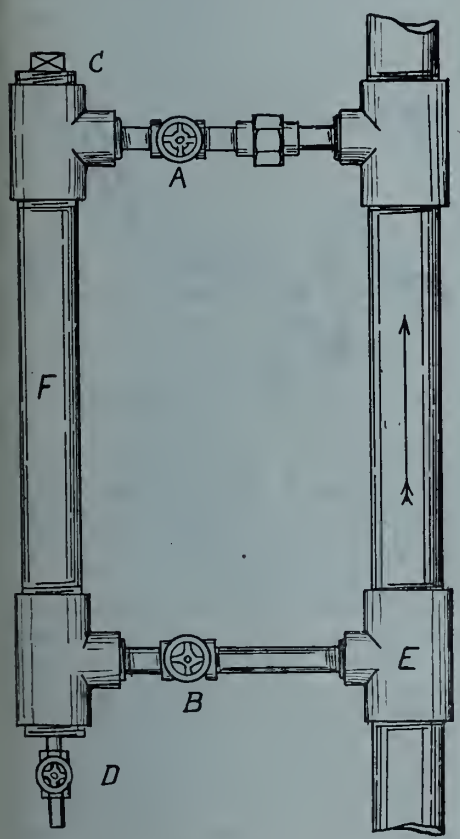
By J. Kington.

MANY engineers desire to feed dissolved soda solution or other boiler compound to the feed water after the water leaves the pump. Many devices for this purpose have been described. The idea shown in sketch is about as simple an arrangement as can be put together.

E is the feed water pipe from the pump.

A and B, are ⅜-in. pipe connections from the 2-in. pipe F to feed pipe E.

Close valves A and B, remove plug C.



SIMPLE BOILER COMPOUND FEEDER.

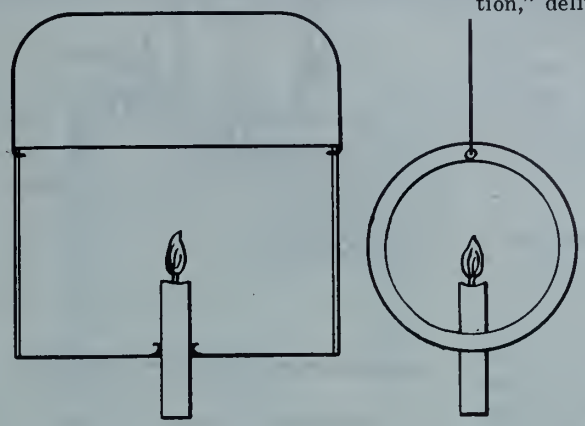
Open drip D and allow pipe F to empty. Close D, fill pipe F with the compound, screw in plug C, and slightly open A and B valves.

A nipple and valve can be used at C instead of the plug if desired. A glass can be attached to pipe F if the rate of flow of feed is wanted to be noted, but connected just as shown it has given satisfaction.

A TIN "CANDLESTICK"

By "Mac."

A CANDLE, a tin can, and a piece of stiff wire, can be evolved into a very serviceable make-shift lantern, especially for working under drips. A hole is made



A TIN CANDLESTICK.

in one side of the can midway between the ends and gradually enlarged until the candle can be pressed in, if possible leaving the tin in such a condition that a certain amount of spring is provided to retain the candle in position. Small holes are then punched in the ends, opposite the candle hole, and the wire bent to form a suitable handle. This simple device has been successfully used in places where an unprotected candle could not be depended on for light, and where even a carbide lamp with naked flame projected horizontally would occasionally be extinguished by the drip. A lantern having a glass chimney was practically out of the question, due to the breakage of the glass and subsequent extinguishing of the light by the water.

BRIQUETTED COAL AND COKE

By O. C.

THE utilisation of small coal by mixing it with pitch and compressing the mixture into briquette form has been carried on for many years, but not so extensively in this country as on the continent, where much of the surplus pitch from English gas-works was formerly shipped for that especial purpose. In Britain the industry is confined chiefly to the South Wales coalfield, which produced in 1914, 1,600,000 tons, of briquettes out of a total British Production of 1,840,000 tons. Ninety-six per cent. of the coal briquetted was small Welsh steam coal. In briquetting the coarsely ground coal is dried, mixed with 6.5 to 8 per cent., of its weight of pitch, passed through a disintegrator, thence to a heater to soften the binder, and on to the briquetting machine.

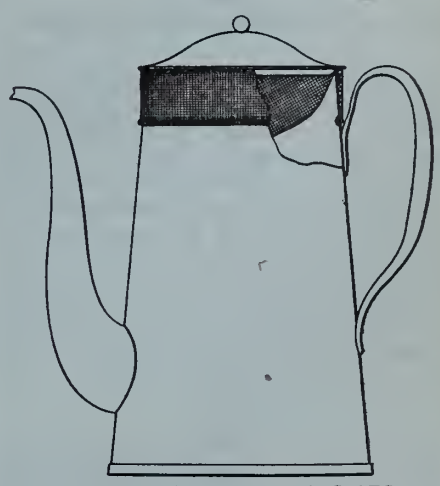
Of more recent date is the application of the briquetting process to coke, and more particularly to the small waste which accumulates at gasworks, and is of little value. The method of use is of considerable importance at present, because, with the increased production of tar and the closing of the Continent to the shipments of pitch, this material is accumulating at most works, and the use of a portion to assist in converting the unmarketable coke into a fuel of the selling value of $3.00 per ton is a double economy. In his recent Harvard lecture on "Coal and its Economic Utilization," delivered before the Royal Society of Arts, Professor Brame gave an account of a coke briquetting plant installed at Smethwick Gasworks over a year ago, which has proved very satisfactory. In manufacture the coke dust is graded to pass a ¼-inch mesh sieve, and is mixed with 8 per cent. of pitch, this mixture being fed to the disintegrator. In the heater a little tar is added, and the hot mass briquetted at 6 tons pressure.

At Smethwick the plant relieves the works of about one-sixth of the pitch made. If then coke breeze were also briquetted, one-third of the pitch could be utilised. The briquettes are suitable for closed stoves, ranges, etc., and form the only boiler fuel used at the works. For the usual open grate the draught is insufficient to burn them without a proportion of ordinary coal.

INEXPENSIVE OIL FILTER

By J. Haliburton

CONSERVATION is an essential factor in every line of industry, and nowhere is this more pronounced than in the power plants of the country. Waste under existing conditions is next to criminal, and it is a commendable feature to not only



OIL FILTER USING STOCKING LEG.

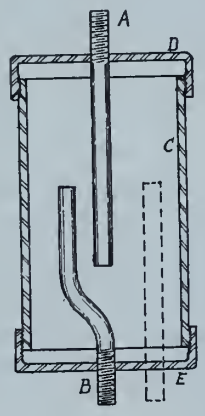
eliminate all waste but to utilize to the utmost all available material so as to maintain the maximum efficiency is service and economy. The accompanying cut illustrates a very serviceable yet inexpensive strainer or filter for cylinder

oil. This consists of a discarded teapot fitted with a portion of a close woven stocking leg. The short piece was sewn across one end and the open end placed over the top of the teapot body, the end of the fabric being provided with an elastic band or other means of securing it to the outer surface of the vessel; a groove similar to that shown offering an excellent facility for securing same. The loose end of the stocking leg is then allowed to sag down into the teapot to form a filtering pocket into which the oil is poured and thereby strained before it passes into the interior of the teapot, from which it is afterwards used by pouring from the spout in the ordinary manner. To prevent the flange of the lid cutting the fabric, it is either removed or given an inward curl.

TRAP FOR STEAM PRESSURE GAUGE

By John Thorn.

THE trap shown can be made with a 1¼-in. nipple C, and two caps D, E. The caps are drilled and threaded to take the two ¼-in. pipes A, B. A straight pipe can be used instead of the bent pipe B, as shown by the dotted lines if desired. It is quite difficult to make the bent circle usually employed in service if a neat job



TRAP FOR STEAM PRESSURE GAUGE.

is desired. The trap shown makes a neat job and if any small amount of dirt gets into the ½-in. pipe B, from the boiler it will settle in the bottom of the trap. The writer has some doubt as to its reliability as he thought that entrapped air might cause the indicating hand on the gauge to vibrate. After a try out this doubt was dispelled.

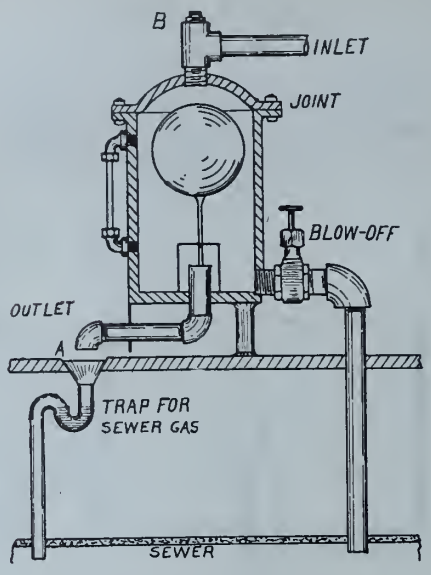
Injury is sometimes done to gauges by the drip cock being left open allowing steam to enter the gage spring.

It is obvious that this can not occur with the trap shown.

INSTALLING GREASE TRAPS FOR SEPARATOR DRIPS

By J. E. N.

FREQUENTLY an ordinary steam trap is connected to the drips from oil seperators on the exhaust pipes from steam engines or pumps. If the drips discharge into an open receiver and the oil is collected for use after being filtered, any stoppage in the trap discharge might be noted before any damage was done, that means oil getting into the steam boilers. If the separator drip is connect-



GREASE TRAP DRAINING TO SEWER.

ed to the sewer directly from the trap, considerable oil might reach the boilers, if a stoppage occurred in the trap, before the stoppage was discovered.

When a heavy cylinder oil is used, a stoppage in such steam traps is quite possible and even probable. Of course there may be exceptions, but many of the traps in question, tapped for half inch and three-quarter pipe threads, have discharge holes no longer than ⅛ inch or slightly over this.

If a trap is used it should be a regular grease trap made for the purpose, with large outlet valves. The connections should be along the lines shown in sketch. It will be noted that the drip in this case is connected with the sewer by a funnel and sewer gas trap, the open space at A enabling the operator to see at once any stoppage in the flow from the separators. These traps cost less than the regular steam traps and only operate successfully with low pressure. Of course grease traps of a different design can be bought.

The gage glass usually fitted to these traps, or any other grease trap, should be treated with suspicion; if they are not blown out regularly the cocks are liable to become choked with thick oil. A ¾-inch blow-off pipe should be a part of each grease trap. If a tee with a removable plug (as at B) is installed, the plug can be removed at times and an oil removing solution poured in; this will remove any oil which may have collected and set on the screen around the drip outlet without taking the trap apart at the joint.

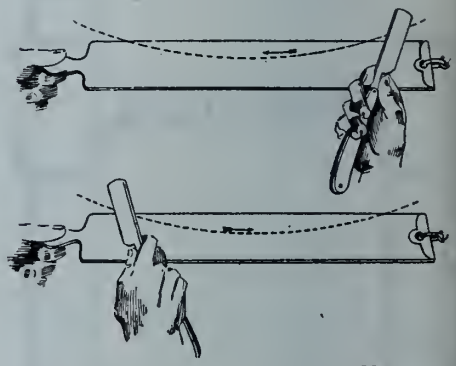
The blow-off can be connected to the sewer as shown, or run to the oil collector. Many dirty boiler jobs could be avoided if more care were taken to install proper grease traps, and to keep them in working condition after being installed.

STROPPING A RAZOR

AT a meeting of hardwaremen in Melbourne recently, the question of how to strop a razor emerged,says Australasian Hardware and Machinery. One man said he had bought about twenty razors in as many years, some of them expensive knives, and was always having trouble. He had come to the conclusion that he couldn't strop a razor properly. Obviously it would be an advantage if every assistant who sells a razor were in a position to tell or show the purchaser how it should be stropped.

The razor is stropped to give it keenness of edge, in reality to clear of foreign matter the microscopic teeth with which the edge is fringed. Hence the desirability of using a suitable strop, a strop with a surface at once "nappy" and soft or pliable. The occasional application of a little olive oil tends to keep the strop in right condition. Even with a good strop, a man may be unable to get his razor right, because his stropping is faulty. The most common mistakes are stropping too heavily and too long. If the razor is in fair order a few passes on the strop, beginning with a slight presure, and ending with almost none, are all that is needed.

Note the position of the hand in the drawing and the direction of travel. The razor should be firmly held, not moved in the fingers, and should always be turned on its back, never on its edge.



RAZOR STROPPING DIAGRAM.

A firm hold of strop and razor and a wrist action of the stropping hand—such are the methods of the expert. If the razor is gripped as shown there will be little, if any, risk of injury to either strop or blade.

The direction, as well as the weight and frequency of the stroke, is of great importance. "Heel to point," it ought to be, but not in a straight line. The curved stroke, experience shows, gives the best results. Rather difficult to accomplish at first, this semi-circular movement of the hand in stropping soon becomes easy enough. It only needs the practice of a few weeks to make it "second nature."

Another important point to remember is that the razor should be laid flat on the strop. The weight of the hand in stropping should really fall on the back of the razor if the rounding and consequent spoiling of the edge is to be avoid-

ed.

Operators' Instruction Course

EDUCATION PAPER—II.

WHAT IS the composition of water?

Theoretically, water is composed of two parts of hydrogen and one part of oxygen, but in practice it includes many other substances, such as lime, magnesia, soda, potash, etc., according to its source.

* * *

What is the composition of air?

Oxygen and nitrogen, in the proportion of 1 to 4, are the principal constituents of air forming the atmosphere. Carbonic acid gas is also present in the proportion of 3 to 4 volumes per 10,000 of air, while industrial conditions influence the amount of other impurities which may assume serious proportions in certain localities.

* * *

What is the composition of coal?

Coal is an impure form of carbon, formed by the decomposition of vegetable growths which existed at one time on the earth's surface. It exists in various qualities, according to its percentage of carbon and volatile matter. Welsh anthracite has over 90 per cent. and lignite about 60 per cent. of carbon, while ash and volatile matter vary from 3 to 30 per cent. respectively.

* * *

How much coal is consumed per horsepower in a large modern power house?

Steam-driven electric plants of large size have operated with as low as 10 lbs. of steam per indicated horse-power, and boiler tests have shown evaporations exceeding 10 lbs. water per lb. of coal, which would result in 1 lb. of coal per horse-power. This is about the low limit for high-class efficiently operated plants, the great majority averaging from 2 to 4 lbs, of coal per horse-power per hour.

* * *

How much water can be evaporated by 1 lb. of the best coal?

The usual value assumed for the best coal obtainable is 14,700 B. t. u. per lb. Divide this by the latent heat of steam and the evaporation from and at 212 deg. is obtained. Thus 14,700÷212= 15.2 lbs. of water. This is never attained in practice, as average run of mine coal has seldom more than 8,000 B. t. u., the results from which are further affected by boiler efficiency. From 7 to 10 lbs. of water per lb. of coal is the usual amount evaporated, under ordinary conditions.

* * *

How much coal per sq. ft. of grate surface can be burned under normal, natural and forced draft?

From 12 to 30 lbs. per hour are the limits from which reasonable efficiency can be obtained with natural draft. Forced draft, either pressure or induced, enables consumptions up to more than 100 lbs. per sq. ft. per hour to be obtained, but with a great drop in efficiency. The highest evaporative efficiency results have all been obtained with a coal consumption at or under 12 lbs. per sq. ft. of grate surface per hour.

* * *

How many B. t. u. does one pound of fair-grade coal contain?

A fair grade of Canadian coal, free from excessive ash, should average 10,000 to 12,000 B. t. u. and selected quality, based on known analysis, from 13,000 to 14,000. Run of mine with excessive ash may not exceed 7,000 B. t. u. per lb.

* * *

What should be the tensile strength of boiler plate?

Modern practice calls for approximately 62,000 lbs. per sq. in. tensile strength in mild steel boiler plate, accompanied by an elongation of 20 per cent. in 8 in. Various bending tests are also specified to insure the proper temper of material.

* * *

What should be the tensile strength of rivets used in boiler construction?

The tensile strength requirements of rivet bars are practically the same as boiler plate, but special allowances are made in boiler design, to provide for them being in shear, instead of tension. The shearing strength of rivet steel is, therefore, taken at 85 per cent. of the tensile strength, and the diameter must not be less than the thickness of the plate.

* * *

What should be the lowest temperature of a furnace when combustion of coal is going on?

The lowest temperature at any time should really be the highest possible for the particular grade and quantity of fuel being used, if efficiency is aimed at. A temperature of 1,400 degs. with fuel consumption of 10 or 12 lbs. per sq. ft. of grate is about the low limit, and with good fuel and combustion should be 1,500. Increased rates of consumption will yield furnace temperatures around 1,800 deg. this being the temperature in the chamber and not in the actual body of the fuel, which is much higher.

* * *

State a rule for finding the size of safety valves for steam boilers?

Safety valve areas are frequently determined with relation to the grate area and the pressure carried, but this method is not satisfactory unless it assumes a maximum rate of fuel consumption. To be correct, a rule for safety valve areas must take into consideration the lift of valve, the heating surface, and the water evaporated. A rule used by some authorities is

$$A = .2074 \times \frac{W\ G}{P}$$

in which A=the area of the safety valve in sq. in.

W= pounds of water evaporated per sq. ft. of grate surface per hour.

P=absolute pressure per sq. in.

G=Grate area in sq. feet.

* * *

Give the principal dimensions of a 60 in. dia. by 14 ft. long horizontal return tubular boiler.

Thickness of shell, ⅜ in.; thickness of head 7/16 in.; length of tubes 13 ft.; number of 3 in. tubes, 82; if 4 in. dia., 50; length of furnace, 5 ft.; weight of boiler about 95,000 lbs. The foregoing thicknesses with double-riveted lap joint represent average practice for 100 lbs. working pressure. If for 150 lbs. pressure, approximately 1/16 should be added to the above thickness.

* * *

What does the horsepower of a boiler depend on?

The power of a boiler depends chiefly on two factors—the area of the grate, and the area of the heating surface. The proportions adopted by makers vary considerably. A ratio of 34.5 to 1 heating surface to grate area is average practice, and assuming an evaporation of 3 lbs. of water per sq. ft. heating surface, the normal power capacity of a boiler would be found by multiplying the sq. ft. of heating surface by 3, and dividing the result by 34.5.

READERS' QUERIES AND ANSWERS

1—What horse-power is required to operate an air compressor with cylinder 16 in. in diameter by 24 in. stroke, discharging at both ends against a pressure of 90 pounds per sq. inch? A belt flywheel, 12 ft. in diameter, is the driving medium, and the revolutions are 100 per minute.—A. R. P.

In order to calculate the required horse-power, it is necessary to know the mean effective pressure and also make

an allowance for friction. Assuming these as 30 lbs. per sq. in. and 20 per cent. respectively, the formula is:

Area of piston in inches, × m. e. p. × piston speed in ft. per min., the whole divided by 33,000, thus for the dimensions given, we have

$$\frac{201 \times 30 \times 400}{33{,}000} = 73$$

20 per cent. of 73=14.6
Total horse-power=87.6

—W. M. McRobert

* * *

2—What is the refrigerating capacity of a double-acting ammonia compressor whose cylinder is 8 in. in diameter and stroke 16 in. when running at 100 r.p.m.? The piston rod diameter is 2 inches.—A. S.

This question is not complete, as suction or back pressure and discharge pressures are not stated, so for convenience the writer has assumed standard conditions of 15.67 lbs. suction and 185 lbs. discharge pressure. The volume of cylinder swept through by piston in one minute equals

$(8 \times 8 \times .7854 \times 2 \times 16 - 2 \times 2 \times .7854 \times 16) \times 100 =$
155823.36 cu. in. =
90.17 cu. ft. per min.

At the pressures given above, it is theoretically necessary to pump 3.83 cu. ft. of ammonia gas per minute to produce 1 ton refrigerating capacity in 24 hours, therefore, capacity of machine equals 90.17 ÷ 3.83 = 23.5 tons. Practically speaking, the capacity would be about 80 per cent. of this or about 18 tons.—S. Balmfirth.

* * *

3—How many tons of work are performed by an ammonia condenser using 300 Imperial gallons at 60 degs. F., the final temperature of which is 90 degs. F.?—A. S.

It is assumed that the quantity of water used is per min. which would give the following result: Total heat absorbed by condenser equals

$300 \times 10 \times (90 - 60) = 90{,}000$ B.t.u. per min.

$90{,}000 \times 60 \times 24 =$
129,600,000 B.t.u. per day.

Since 1 ton of refrigeration equals 288,000 B.t.u., the amount of refrigeration performed equals 129,600,000 ÷ 288,000 = 450 tons.—S. Balmfirth.

* * *

4—How many tons of work result from pumping 160 U. S. gallons of brine per minute through a brine cooler? The temperatures of the ingoing and outgoing brine are 15 degs. F. and 35 degs. F. respectively.—A. S.

Assuming a specific gravity of 1.14 for brine, 160 U. S. gallons would weigh

$160 \times 8.345 \times 1.14 = 1522.128$ lbs.

The degrees change in temperature is 35 — 15 = 20, therefore, the total heat absorbed is

$1522.128 \times 20 = 30{,}442.56$ B.t.u.

The total refrigeration performed per day would, therefore, equal

$$\frac{30{,}442.56 \times 60 \times 24}{288{,}000} =$$

152.21 tons per day.

—S. Balmfirth.

* * *

5—The temperature of liquid ammonia is 84 degs. F., and the temperature of brine in the cooler is 2 degs. F. The liquid, in order to evaporate, must first be cooled from 84 degs. F. to 8 degs. F. The cooling takes place right behind the expansion valve, where part of the liquid evaporates and extracts the heat from the remaining liquid. What is the percentage of loss due to cooling the liquid? The latent heat of the liquid at 80 degs. F. is 560.5 B.t.u.—A. S.

In cooling the liquid from 84 degs. to 8 deg. the drop in temperature is 72 deg. The specific heat of the liquid is 1.1214, which, multiplied by 72, equals 80.74 B.t.u. loss.

The percentage of loss is, therefore, equal to

$$\frac{80.74 \times 100}{560.5} = 144$$

—S. Balmfirth.

* * *

6—A suction pipe, not insulated, passes through a room whose temperature is 60 degs. F. As the pipe must be frosted to deliver saturated gas, a loss is the result. How many B.t.u. are so lost in condensing and freezing one pound of moisture on the pipe?—A. S.

The total B.t.u. lost per lb. of moisture frozen on the pipe may be calculated thus: latent heat extracted in condensing, 966.7 B.t.u.; to cool from 60 deg. to 32 deg. = 28 B.t.u.; latent heat extracted in freezing, 144 B.t.u.; total, 1,138.7 B.t.u.—S. Balmfirth.

ROPE DRIVING

THE rope drive as a power transmission factor has not lost any of its hold in the estimation of those who have made a careful study of its operation. Aside from the question of superlative merit of either the English or American systems, there is undoubtedly a field of usefulness in which it equals and possibly excels other methods.

Regarding the two types of rope generally used—namely, three-strand and four-strand—the former can be made more pliable than the latter, and it is also stronger; but these advantages are more than counterbalanced in the four-strand rope, because compared with the three-strand, it stretches very much less, and has a larger surface in contact with the pulley grooves. It is also capable of a stronger splice. A well-made four-strand rope is, moreover, nearly as strong as a three-strand. but it requires more skill to splice it. The general opinion, now, is that cotton is the best material to use for driving-ropes, and Egyptian cotton, though a little more expensive than American, is generally preferred.

Screenings

Willis—"Bump has a very up-to-date office."

Gillis—"Yes. He has one of these office systems where you can find just what you want when you don't want it by looking where it wouldn't be if you did want it."

Mrs. Casey—"Me sister writes me that every bottle in that box we sent her was broken. Are ye sure yez printed 'This side up, with care on it!'"

Casey—"Oi am. An' for fear they shouldn't see it on the top. Oi printed on the bottom as well."

Did Not Wish To Offend—"John," said Mrs. Mellen to her man servant, "Can you find out, without asking the cook, whether the tinned salmon was all eaten last night? You see, I don't wish to ask her, because she may have eaten it, and then she would feel uncomfortable."

"If you please, ma'am," replied the man, "the new cook has eaten the tinned salmon, and if you was to say anything to her you couldn't make her feel any more uncomfortable than she is.

Sandy McNab, being a popular and well-known member of the village kirk, was asked by the minister to canvass the other members on behalf of a war charity he was interested in.

Soon afterwards the minister met Sandy walking irresolutely along the road, and at once guessed the cause.

"Man, Sandy," he said earnestly, "I'm sorry to see you in this state."

"Ah, weel, it's for the good of the cause," replied the deliquent quite happily. "You see, meenister, it's through these subscreeptions. I've been down the glen collectin' fun's, an' at every hoose they made me hae a wee drappie."

"Every house! But—but—but surely Sandy, there are some of the kirk members who are teetotallers?"

"Aye, there are; but I wrote tae those."

The man stammered painfully as he stood in the dock at the police court. His name was Sissons, and it was very difficult to pronounce.

He had had the misfortune to stay out late and make an uproar the previous night, so that he had to account for it before the magistrate next morning.

"What is your name?" asked the magistrate.

Sissons began to reply.

"Sss-s--s---s---"——

"Stop that noise and tell me your name," said the magistrate testily.

"Sss-sss-sss-ss"——

"That will do," growled the magistrate severely. "Constable, what is this man charged with?"

"Yer worship, I think he's charged with sodywather," replied the policeman earnestly.

Steam Power Plant Auxiliaries

FEED-PUMP GOVERNORS

THE development of governing devices, whereby the speed of boiler-feed pumps is automatically varied to suit changing conditions, is the final step in the elimination of the personal element in the control of boiler feeding plant. The various types of regulators described in previous articles have, as their prime function, the opening and closing of an individual control valve on the feed pipe of each boiler so that the necessary amount of feed water is admitted as required. They are operated directly through variations of water level and are entirely independent of the pressure at which the boiler may be working, and it is this question of boiler pressure, the variations thereof, and the closing of the feed control valve by the regulator which have combined to stimulate the development of pump governors.

Assuming the case of a large battery of boilers on which there was a more or less constant load, a central feed-pump installation might be under constant operation with very little variation in speed due to the steady demand for feed water from the boilers as a whole,—while one boiler might be unloaded due to cleaning fires, etc., another might be taking on extra load and so balancing operations that while their individual feed regulators were in active use, their combined effect on the pump speed would be almost unnoticeable, and close attention by the operators could quite well dispense with a pump governor if such attention could be relied on. The use of a pump governor however not only removes the "if," but insures a closer degree of uniform delivery pressure by the pump than is possible by any hand control.

Excess Pressure

In order to force water into a boiler, the feed pump must have sufficient steam capacity in the cylinders to insure a reasonable excess of pressure in the feed pipe over that of the boiler, say from 5 to 15 lbs. per square inch or more. This excess extends from the discharge side of the pump plunger or piston to the point in the pipe where the feed-regulator is attached, and decreases slightly as it approaches the boiler. When the feed-regulator opens up the control valve, less resistance is offered to the passage of the water, consequently the pump operates at an increased speed. When the regulator causes the control valve to close down some, the reduced area causes the delivery pressure of the pump to increase, until, when it is shut tight, the pressure at the pump will assume the maximum obtainable with the available steam pressure.

Such conditions, of course, are not at all beneficial to the pump and piping, consequently various devices have been invented to vary the speed of the pump according as the control valve on the feed pipe allows more or less water to pass, the pressure of the water being always kept at a higher point than that of the boiler. The principle of operation is therefor based on the difference between the boiler pressure and the pump delivery pressure. Increased demands for feed water mean a reduction of this difference, while the absence of demand results in an increased difference. The available pressure due to this difference is utilized to automatically control the supply of steam to the pump so as to dispense entirely with hand regulation even to the point of stopping and starting the pump.

Pistons, diaphragms, weights, and springs, are variously combined to obtain the desired result, the discharge pressure of the pump being piped to one side of the operating element, while the other side is either exposed to boiler steam pressure, or counterbalanced in a suitable manner permitting of adjustment.

Fulton Pump Governor

This design of governor employs an adjustable counterweight for determining the amount of excess pressure carried and is arranged so that the piston or diaphragm carries boiler pressure on one side and pump discharge pressure on the other, thus requiring the counterweight to balance only the difference between the two, which, at 10 lbs. per square inch involves only a small size counterweight. Both piston and diaphragm types are made, as illustrated in Figs. 1 and 2. The external appearance is slightly different, while internally they are identical so far as the steam controlling mechanism is concerned.

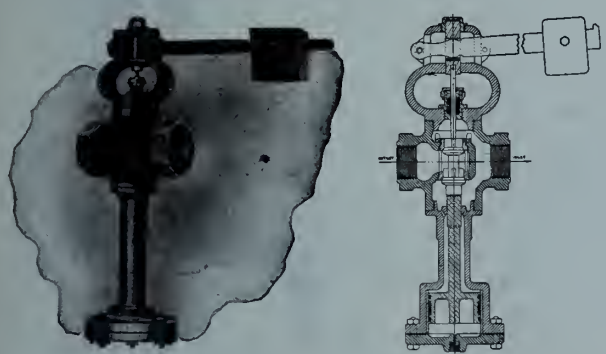


FIG. 1. PISTON TYPE OF "FULTON" GOVERNOR.

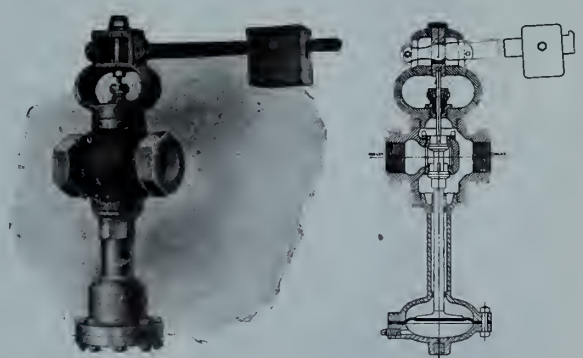


FIG. 2. DIAPHRAGM TYPE OF "FULTON" GOVERNOR.

The piston type, Fig. 1, has a small cylinder formed at its lower end, in which works a metallic piston connected by a rod to the double heat steam valve on the underside of the valve seats. Extending upwards from the valve, through a packing gland, is a spindle, the upper end of which engages with a horizontal lever carrying an adjustable counterweight. Steam from the boiler enters by the inlet, and obtains access to the upper side of the piston through small holes provided for that purpose. The lower side of the piston is connected by a small pipe to the pump discharge, while the steam outlet is connected to the pump steam chest.

Assuming that the excess of pressure desired in the feed pipe is 10 lbs. per

that in order to close the double beat valve the water pressure below the piston must be that much higher than the steam pressure. The excess pressure, of course, can be varied to suit individual requirements, but when once set will remain constant no matter how much variation may take place in the steam pressure of the boiler.

The diaphragm type, Fig. 2, has a flexible diaphragm of suitable material substituted for the piston, and operates against a flattened end of the piston rod. The spaces surrounding the rod down to the diaphragm are also connected to the steam space above, provision being made

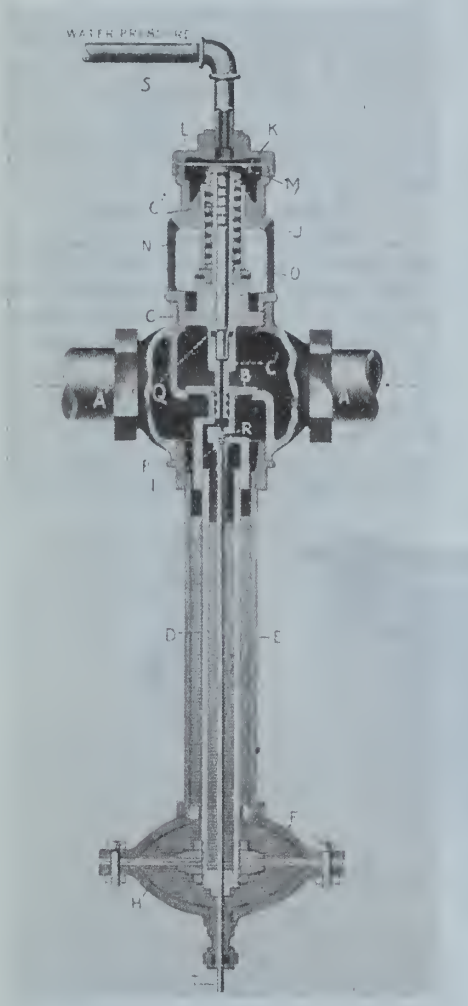


FIG. 3.—SECTIONAL VIEW OF "LOCKE" PUMP GOVERNOR, SHOWING PILOT VALVE AND DIAPHRAGM ARRANGEMENT.

to cover the upper side of the diaphragm with water to avoid damage to the material from the steam heat. In the manner of installation and operation, this type is exactly similar to Fig. 1, both of these devices being the product of the Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.

Locke Pump Governor

This governor is designed for close accurate work in which the water pressure is required to be maintained at a definite point. The construction is rather different from the majority of governors and involves the use of a single beat valuve, a spring-controlled pilot valve operated by the water pressure, and a diaphragm operated by the steam pressure. Fig. 3 shows a section of the apparatus, by referring to which the working will be clearly understood.

Boiler steam enters at A on right as shown by arrow. Water pressure from pump discharge is piped through S onto top of diaphragm L, and at maximum pressure forces down the spring below it which is adjustable by means of sleeve O. In forcing down the spring it causes a small stem to close a valve Q in the bushing C. The lower end of this bushing is a steam tight fit in the centre of main valve B, which moves vertically on this part as shown. Valve B is of hollow construction, carried on the upper end of a tube which in turn is fastened by its lower end to diaphragm H. Under working conditions the spaces in and around this tube are filled with water, the inner body of water being connected with the water below the diaphragm. A small central spindle T enables exhaust valve R to be regulated to the small amount necessary for successful operation.

Assuming the parts to be in position as shown, i.e., steam shut off, and no water pressure—when steam enters through A it presses valve B tightly on its seat, and passes through pilot valve Q down into the central water column, causing the pressure below the diaphragm to increase and force it up so that the tube lifts valve B off its seat and allows steam to pass through to the pump. The two columns of water are now balanced and keep valve B open. Meanwhile, the pump discharge pressure is building up until the water pressure, operating against the adjusting spring, forces down the pilot valve and stops the passage of steam through the central passage to the inner water column. The exhaust valve R allows this pressure to drop to that of the outgoing steam and thus equalizes the pressure on both sides of the diaphragm. When this takes place, the steam passing through closes valve B and stops the pump.

When the water pressure falls again, the spring N lifts up the pilot valve and allows steam to pass to the central water column and open up the main valve again. The governor therefore will allow steam to pass to the pump whenever the water pressure is less than that required to balance spring N. The action of the exhaust valve R is adjusted by turning spindle T to right or left. This governor is one of several types built by the Locke Regulator Co., Salem, Mass., which includes spring and weight adjusted apparatus for a variety of purposes.

S-C Pump Governors

The use of a flexible diaphragm operating against an adjustable spring so that the mechanism will respond to minute variations of feed pressure is a feature of this governor. The fact that the operation of the valve is spring controlled enables the governor to start and stop gradually instead of working at full open or full closed positions only. square inch, the counterweight is set so It is thus capable of varying the pump speed by small increments to suit similar variations in the demand for feed water as happens when a continuous graduated feed water regulator controls the supply to the boiler.

A sectional drawing of this device is shown in Fig. 4. A double seated valve R is carried on the end of valve stem T which extends through spring case I to diaphragm H. By means of screw L and yoke M, the compression of spring K is varied, so that when the desired pressure is attained by the feed water on the other side of the diaphragm, valve R is in closed position. Spring case I completely encloses the parts so that the only packed joint is at N where the ad-

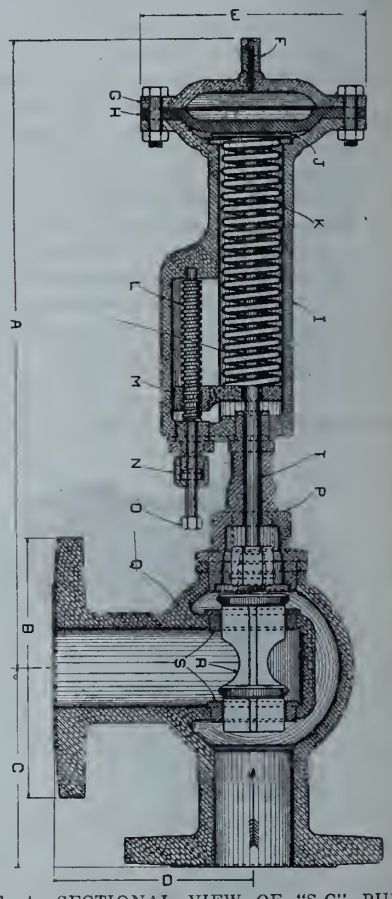


FIG. 4.—SECTIONAL VIEW OF "S-C" PUMP GOVERNOR, SHOWING ADJUSTING SCREW FOR REGULATING MAIN SPRING.

justing screw passes through. As this part is only used when changing adjustment it will be seen there is an entire absence of friction other than that due to the weight of the parts.

When in operation, the spring case is filled with water of condensation and the steam pressure is exerted on this continuously so that the spring has only the excess pressure to balance. When this pressure drops, the valve R is opened to suit the amount of drop,—when more or less water is being used, the governor never shuts off, but floats with the demand and maintains the desired excess water pressure above that of the steam, regardless of the demand and will change the steam supply immediately.

This governor is built by the S-C Regulator Co., Fostoria, O.

Projects and Developments

TRADE GOSSIP

Arthur Vincent, C.E., has been appointed town engineer of Longeuil, P.Q., in succession to the late F. Barbeau.

Courtney, B.C.—The new general store of the Comox Co-operative Society has been equipped with a 1-ton "Armstrong" refrigerating plant.

St. John's, Que.—The Laurin & Leitch Construction Co., Montreal, have the general contract for pumping and filtration plant for the Town Council.

Tecumseh, Ont.—J. R. Sculland, of Windsor, has the contract for reinforced concrete water tower and basin costing $6,500 for the Eau Claire Waterworks Co.

Vancouver, B.C.—Howard's chocolate factory has been equipped with a ½-ton refrigerating machine, furnished by the Armstrong Machinery Co., Spokane, Wash.

Port Arthur, Ont.—The Canadian General Electric Co. has secured the contract for the sub-station and electrical equipment for the Eastern Terminal Elevator.

Cornwall, Ont.—The Cornwall Dairy Co. have established a new creamery and dairy, and have built cold storage rooms in connection with same. They will install a refrigerating plant.

Swanson Bay, B.C.—A 3-ton refrigerating plant, furnished by the Armstrong Machinery Co., Spokane, Wash., has been installed on the premises of the Empire Pulp & Paper Co., at Swanson Bay.

McLeod, Alta.—The meat market of P. Burns & Co., at McLeod, has been remodeled and equipped with a 1-ton refrigerating plant, furnished by the Armstrong Machinery Co., Spokane, Wash.

Montreal, Que.—It is expected that the Montreal Tramways Co.'s new steam plant will be in operation in a few weeks. This plant has a capacity of 12,000 k.w.h., or of about 17,000 h.p., developed from steam turbine, and a similar installation will be added next year, making a total of 34,000 h.p.

Hydro Commission Takes Over Power Co.—The Hydro-Electric Commission on Aug. 2, formally acquired the plant of the Ontario Power Co., the largest and most efficient developing plant on the Canadian side of the Niagara River. This plant was purchased some months ago by the Commission for $22,000,000, and it will form an important link in the Chippawa Creek development scheme, the ultimate capacity of which will be 900,000 horse-power.

Roland C. Harris, Commissioner of Works for the City of Toronto, has been appointed to act, in an honorary capacity, as Fuel Commissioner for the Province of Ontario, in association with the Federal Fuel Commissioner, C. A. McGrath. Mr. Harris will co-operate with the Federal Commissioner in all matters affecting the fuel situation within the Province of Ontario, and it is understood that his appointment will be ratified by a Dominion Order-in-Council.

James Fulton Cummings, a pioneer electrical engineer, who for many years was associated with the interests controlled by Thomas A. Edison, died on July 27, at Long Beach, N.Y. Mr. Cummings, who was born in London, Ont., 48 years ago, installed the first electric light stations in Philadelphia, Cincinnati and a number of other cities. He then went to Russia, where he worked out the plans by which electric wires in St. Petersburg, as the capital was then called, were placed in underground conduits. He did similar work in London and other English cities. He was considered one of the foremost engineers in that particular line of work.

CATALOGUES

Engine Room Supplies is the title of a booklet recently issued by the Quaker City Rubber Co., Philadelphia, Pa. This booklet is exceptionally complete and comprehensive, and will serve as a useful guide to the engineer in selecting packings, hose and other necessary engine room requirements. The principal lines described include Daniels', P. P. P., rod packing, Ebonite sheet packing, gaskets and steam hose. "Crown" and "Quaker City" packings. The booklet is pocket size and contains 63 pages with index.

Air Compressors. — Bulletin K-500-A, illustrating a line of power driven, single stage, straight line air compressers manufactured by the Canadian Ingersoll-Rand Co. of Montreal. These machines are designed for motor or belt drive and are furnished with a special short belt drive where floor space is a consideration. They are intended for use in industrial and mining plants where units of 950 cu. ft. displacement and under per minute are required. Eighteen sizes are built giving a wide range of choice.

Feed Water Treatment.—The Dearborn Chemical Co., of Canada ,Ltd., Toronto, are distributing a bulletin describing the Dearborn scientific treatmen of boiling feed waters. The bulletin gives a list of the substances commonly held in solution in feed waters and describes their action either in the formation of scale or corrosion of the boiler plates. The bulletin also deals with the Dearborn method and boiler preparations.

Electric Lamps.—Bulletin No. 78 describes the Cooper Hewitt electric lamps for photographic purposes. The bulletin gives full particulars and prices of the various outfits and different apparatus used in connection, accompanied by illustrations. The bulletin also contains suggestions as to the proper outfit to be used for various purposes in photography with illustrations showing studio arrangements. Copies of the bulletin may be obtained from The Cooper Hewitt Electric Co., Hoboken, N.J.

Steam Specialties—The V. D. Anderson Co., Cleveland, Ohio, have issued a new and well gotten up catalogue entitled "Anderson Steam Specialties," which include steam and air traps, steam and oil separators, water columns, pressure oil filters, copper floats, etc. The construction and operation of each product is fully described, accompanied by illustrations showing exterior and cross sectional views. Tables are also included giving the principal dimensions and other data for each size of trap or separator, etc. The catalogue also contains plates showing three arrangements of the Anderson oiling system.

Mechanical Rubber Goods, Valves.—Catalogue and price list No. 8 deals with an interesting line of valves, packings, and mechanical rubber goods manufactured by Jenkins Bros., Ltd., Montreal. This is a useful catalogue to have on file for reference, as it covers a full line of the above products and contains considerable descriptive matter about each in addition to the price lists. The catalogue is fully illustrated, while the concluding section No. 8. contains a price list of parts, tables of weights, and dimensions, together with diagrams, and also provincial registration numbers for the various types of valve. In this section is also included diagrams in connection with the dimension tables. The catalogue contains 252 pages, including a complete index and is bound in substantial cloth covers.

Progress in New Equipment

NEW TYPES OF OIL CIRCUIT BREAKERS

TO its line of type B oil circuit breakers, the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa., has added the two types of breakers illustrated. These are designated as type B-2 and B-3; they are for use on alternating current circuits up to 23,000 volts. Type B-2 breakers have a carrying capacity of from 300 to 2,000 amperes; type B-3 of from 300 to 1,200 amperes. Distinctive features of this line are rigidly clamped porcelain pillar bushings, self-cleaning butt brush contacts, auxiliary arcing contacts and spring-accelerated opening. Due to careful design, these are the most compact single-frame breakers produced.

Type B-2 breakers are furnished for panel-mounting, hand operation, or for wall or pipe-frame mounting, electrical operation. Type B-3 breakers are furnished for wall or pipe mounting only, for hand operation through bell cranks, or for electrical operation. For both types, tripping may be either automatic or by hand. Hand-operated breakers are actuated by a handle projecting through a cover-plate on which is mounted the automatic trip coil (if any). When the breaker is electrically operated, the trip coil is mounted on the face of the panel. Remote control breakers operated by bell cranks and rods are provided with a spring to assist the force of gravity in opening. A dashpot brings the moving parts to rest without shock.

When pressure is brought to bear on the main contracts, as the breaker closes, the bent copper leaves of the moving members wipe across the plane stationary contacts, thus ensuring a solid metal-to-metal contact. Arcing contacts consist of a copper-tipped spring plunger mounted on the moving element, which bears on a copper stud on the fixed element.

"MICHELL" THRUST BEARINGS

WITH a view to manufacture in quantity and placing them on the market on the same basis as that on which ball bearings have long been sold, Broome & Wade, of High Wycombe, Berks, England, are now standardizing certain sizes of Michell thrust bearings, says Engineering.

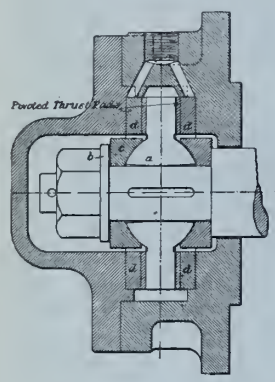


FIG. 1.

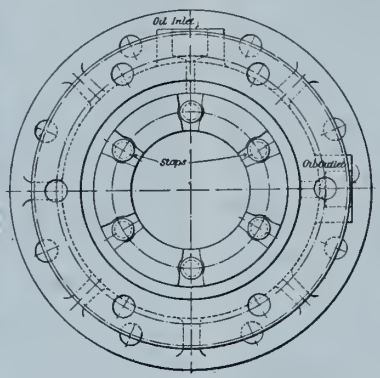


FIG. 2.

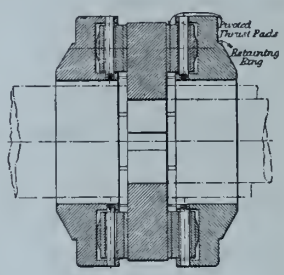


FIG. 3.

MICHELL THRUST BEARING DETAILS.

One form of standardized design is illustrated in Figs. 1 and 2. In this case the thrust collar (a) is bored to a barrel section and instead of being clamped between its spherical seats is loosely held, as is indicated by the space shown between the washer (b) and the opposing face of the seat (c). It is thus capable of taking slight tilts so as to distribute the load equally, in spite of any bending or deflection of the shaft. The collar transmits the thrust to the series of pivoted blocks or pads shown in position at (dd)—of these one set serves to take a thrust and the other a pull. Provision is made, it will be seen, for a continuous supply of oil. This pattern, being entirely enclosed, is suitable for use on pumps, fans or worm gears.

Another form of standardized thrust block is shown in Fig. 3. Here the bearing is not complete in itself, but is designed to fit into seats machined for it in the gear casing or whatever other machine part to which the bearing is to be applied. In this case the blocks are, it will be seen, mounted on two retaining rings. These, when the bearing is mounted in place, fit on bevelled seats, sufficient freedom being allowed to permit of the pressure being fairly distributed over the pads. The rings are prevented from being carried round with the revolving shaft by feathers on the houisng of the machine. This pattern is made in sizes to fit shafts from 1 in. up to 3½ in. in diameter, and to carry loads from 1,000 lb. to 8,000 lb. In this case the pads pivot about a point contact, whilst in the case of the pattern represented in Figs. 1 and 2, which is intended for heavier loads, the pads have line contact with the housing. Both types of bearing can be run at very high speeds, since centrifugal action in no way affects their working. With loads of 400 lb. to 500 lb. per square inch the coefficient of friction is commonly about 0.0015.

A REMARKABLE OIL ENGINE

By H. P. Hoag

IN the issue of this journal for May the writer described a certain device evolved during his experience in adapting a line of gasoline engines to burn kerosene. The engine illustrated in the accompanying sketch however, is a real kerosene engine that will start and run on kerosene and has neither carburetor nor electrical ignition. It is the invention of a Danish engineer, R. M. Hvid, and is bound to revolutionize the internal combustion engine, giving as it does the same economy as the world famed Diesel engine.

For those unfamiliar with the Diesel engine it might be stated that first, it is a high compression engine, combustion

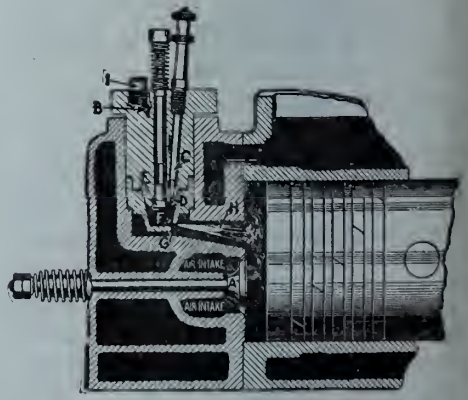


FIG. 1—SECTION OF CYLINDER HEAD SHOWING IGNITION CUP WHICH AUTOMATICALLY FEEDS FUEL TO COMBUSTION CHAMBER.

being caused by the heat of compression which is about 500 lbs. per sq. in., (it being an established engineering principle that a high temperature can be attained by air compression) the resulting

Has Anybody Here Seen Hector?

Has anybody seen Hector at a plant in Missouri, where the engineer had to try to clean the boiler on Sunday because that was the only day it could be spared? Well, the engineer worked all day Sunday and the best he could do with the cleaner he then had was ten tubes per Sunday. The condition of the boiler as to scale kept getting worse and worse. Then Hector was called in.

Hector is a "Bulldog" cleaner and the first day he started chewing off scale, he got 2,000 lbs. from a 300 h.p. Heine Boiler. He cleaned it thoroughly.

Next Sunday the engineer was able to enjoy a well-earned rest.

And you bet he was glad he had thought to call Hector into his plant.

Did anybody see Hector wade through solid closed-up tubes of a B. & W. Boiler in a New York State plant?

Did anybody see him when he ran continuously for 480 hours, removed 6,842 pounds of scale and called for no repairs except drills?

These are the sort of things which Hector is doing all the time.

He's the best little fighter of scale you ever saw. True to his Bulldog nature, Hector never lets go till the tube is clean and shining.

Give Hector a job in your plant.

We have a Catalog which we'll be glad to put in your hands. It describes all Types of Liberty Cleaners. Ask for Catalog H

The BULLDOG Cleaner—for bent tubes—3 and 3¼-in. sizes.

The BULLDOG Cleaner—for straight tubes, 3½ and 4-in. sizes.

Liberty Manufacturing Company

6904 Susquehanna Street
Pittsburgh, Pennsylvania

If any advertisement interests you, tear it out now and place with letters to be answered.

temperature being about 1000 deg. Fahr. Nothing but pure air is taken into the cylinder during the suction stroke, then when the piston reaches the highest point of compression, fuel is injected into the cylinder by means of air compressed to about 800 lbs. per sq. in., then cooled. Combustion begins the instant the oil meets the hot air in the cylinder and continues through that part of the working stroke during which fuel is introduced. While the Diesel type gives the very highest economy known to the internal combustion engine, it is never built in small units owing to the expensive apparatus necessary to inject the fuel under such high pressures.

Wonderful as the reliability and fuel economy of the Diesel engine are, the Hvid principle bids fair to outclass the former owing to its extreme simplicity and ease of starting as well as economy, the fuel consumption being half a pound of fuel oil per horse power hour. Another great point of advantage this new type has over the Diesel is that it can be built in small sizes which of course is out of the question with the Diesel type as explained above. Think of an engine, without carburetor batteries, magneto, spark plug, or wires, or the application of any external heat, that will start and run on most any kind of oil, such as kerosene, distillate, fuel oil, or crude oil, in fact any kind of oil that will flow, machine, fish. lard, linseed, olive or peanut oil. This type of engine is now being built by several firms. It was recently the writer's privilege to investigate several of the Hvid type engines now building in the United States both stationary and marine, which proved very interesting indeed.

In this new principle combustion is obtained by the heat of compression as in the Diesel, but the secret of the new system is in the patented fuel cup which times the ignition and represents the only method by which combustion by compression can be easily controlled.

In the sectional view the burning oil can be seen at H, the principle of operation being as follows. During the suction stroke, pure air only enters the cylinder through the intake valve. Oil is admitted by valve E, the quantity being varied by needle valve C, which is under control of the engine governor. As the piston returns and compresses the air to about 450 lbs. per sq. in. the temperature rises to about 950 deg. Fahr. and heats the small fuel cup red hot which brings about a partial combustion of the fuel oil in the bottom of the cup, causing the pressure in the cup to immediately rise above the air pressure in the cylinder which forces the hot oil out through the small pin holes in the cup into the cylinder when it comes into contact with the heated air in the cylinder and burns as shown at H, forcing the piston forward on its power stroke. It will be seen that this new principle incorporated into a substantial design, doing away as it does with all electrical apparatus for igniting the charge, must result in simplicity and reliability and in turn supersede the gasoline engine for at least stationary, portable and marine work.

TYPICAL AUTOMATIC STARTER EQUIPMENT.

AUTOMATIC STARTERS FOR INDUCTION MOTORS

DUE to the unprecedented demand for manufactured products of every kind, industrial plants in all parts of the country are being taxed to their utmost capacity. In addition, the cost of labor and machinery has been increasing at an extremely rapid rate. The magnitude of these factors has forced manufacturers to employ every means available in an effort to increase production or to reduce operating expenses. This may be accomplished by reducing the number of operators, by simplifying the duties of the present operators so that more attention may be devoted to the production of a larger quantity and a higher grade of product, or by furnishing better protection to the apparatus installed, thereby insuring continuity of service.

TYPICAL AUTOMATIC STARTER EQUIPMENT.

One of the factors by which the desired results may be accomplished is the use of automatic starters and controllers for the motor-driven machinery employed. Among the companies producing such control apparatus is the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., several of whose starters are shown in the accompanying illustrations. These automatic starters are for use with single phase or polyphase squirrel cage and wound-rotor induction motors, where it is desired to start the motor from a remote point, or where automatic acceleration is required to guard against improper starting by unskilled operators. They are simple, reliable, and rugged in construction, consisting of a magnetic contactor panel and a master switch, which may be either a push button, a float switch, a pressure regulator, or similar device for closing the control circuit, depending upon the service. The vital element is the magnetic contactor. The contactors used on these starters are of a type which has been used by the West-

FIG. 2—SIDE VIEW SHOWING CONVENTIONAL APPEARANCE OF ENGINE.

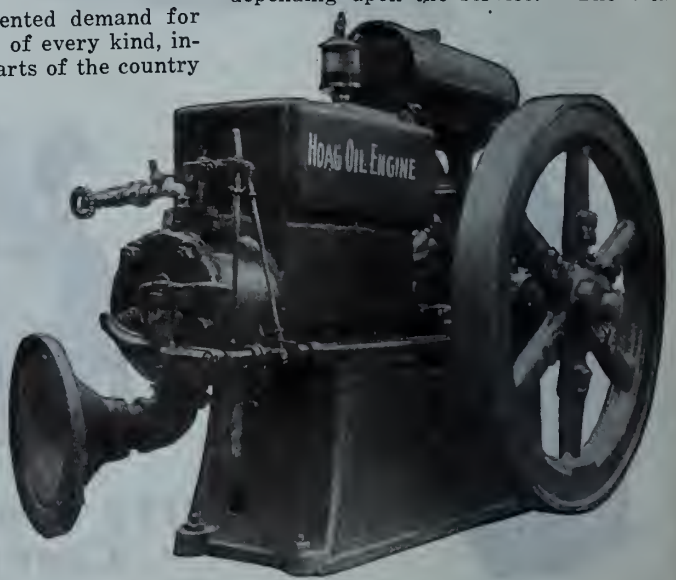
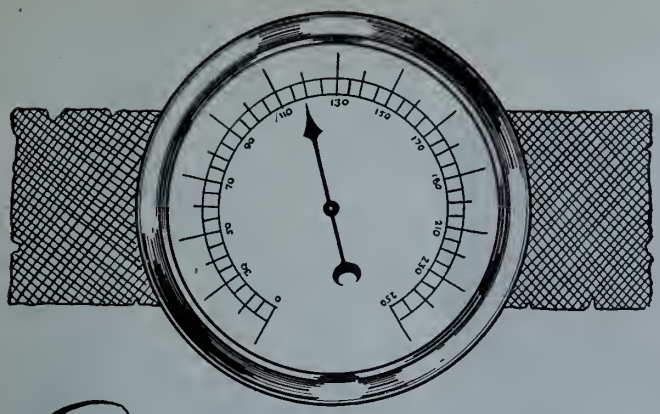


FIG. 3—VIEW OF VALVE AND GOVERNOR GEAR. NOTE ABSENCE OF COMPLICATED MOVING PARTS.



Can you keep the pointer where it belongs?

It's getting near four o'clock. The demand for power is a trifle heavier than usual. The peak is coming. The sockets click one after another in a steady stream. The demand for steam is going up, up, up. Can You Keep The Pointer Where It Belongs?

Sturtevant
(TRADE MARK)

Turbo-Undergrate Blower

will keep steam up. It supplies all the draft you want and just when you want it.

When you buy a blower be sure it's a Sturtevant. The Sturtevant name is a guarantee of mechanical excellence—a guarantee that you will have no breakdown and no bearing trouble.

The Sturtevant Set has generous bearings with oil rings and large reservoirs. One filling will last for weeks.

To prevent the escape of steam from the casing there is a floating stuffing box. If for any reason through neglect or carelessness this is allowed to leak, there is a special "water-throw" collar which makes it impossible for steam to enter the bearings. Furthermore, the floating stuffing box makes it possible to exhaust against back pressure as high as 25 pounds.

If you have trouble getting enough steam or keeping the needle where it belongs, write us for bulletin No. 214-U.

B. F. STURTEVANT COMPANY
OF CANADA, LIMITED
GALT - - ONTARIO
Montreal Toronto Winnipeg Vancouver

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"THE RILEY STOKER"

THE massive steel stacks of the Pennsylvania Railroad Power House in Long Island City were painted seven years ago. Rain, snow, intense heat and constant exposure to gases have left the steel of the chimneys as smooth, strong and rustless as the day it was fabricated.

The stacks had been painted with

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and long, satisfactory service was thus assured.

Our special "R. I. W." Smoke-Stack Paint is particularly adapted to use on unlined steel stacks. It will not peel, crack or blister, and always presents a fine, black, glossy appearance. It is widely used on the stacks of power houses, pumping stations, smelters, foundries, etc.

Another remarkable Toch preservative is No. 137 "R. I. W." Damp Resisting Paint. Red in color, it protects both wood and metal from chemicals and acid fumes, and may be used both indoors and out. Used extensively on tanks and on all structural iron constantly exposed to the weather.

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REMEMBER IT'S WATERPROOF
REG. U.S. PAT. OFF.
STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

inghouse Co. with marked success in steel mill, cement plant, and mine installations where the requirements are extremely severe. The contactors are opened by strong spring action, assisted by gravity. The destructive action of the arc is reduced to a minimum by strong blow-out coils and arcing horns.

The operation of the starters is exceeringly simple. When starting motors driving line shafting, wood-working and metal-working tools and similar apparatus, it is only necessary to press a button and close a small knife or snap switch. The starter then automatically makes the proper connections to limit the starting current to a suitable value and to vary the time required for acceleration according to the load on the motor, thus preventing damage to the machinery by too slow or too rapid acceleration, and saving time by bringing the motor to full speed at the most rapid permissible rate.

CLASSIFIED ADVERTISING

FOR SALE—150 H.P. MOTOR, NO. 4570, SIZE 126Q, 600 R.P.M., 36.5 amp., 2,200 volts, 60 cycles, 3-phase. Canadian Crocker-Wheeler. Apply Howard Smith Paper Mills, Limited, Beauharnois, Que. p8h

FOR SALE—THREE TRANSFORMERS, TYPE D.T., Crocker-Wheeler, K.V. 75, phases 1, cycles 60; primary voltage 2,200; secondary voltage 550; primary amperes 36; secondary amperes 136.4; numbers 2849, 2850, 2851. Apply Howard Smith Paper Mills, Limited, Beauharnois. Que. p8h

ARE you opposed to low cost cup greases?

How do you know that you are now using the most economical cup grease? Your opposition to trying a certain brand of cup grease is the same as opposition to using low cost cup grease.

We can prove to you that

DIXON'S

GRAPHITE CUP GREASES

cost less than others by giving the most perfect lubrication.

The flake graphite used coats the bearing surfaces with a smooth, frictionless veneer and much less grease is used. The small quantity of Dixon's Graphite Cup Grease necessary to use to give perfect lubrication makes it cost less in the long run than other cup greases.

Send for Booklet No. 222-R.

Made in Jersey City, N.J., by the

JOSEPH DIXON CRUCIBLE COMPANY

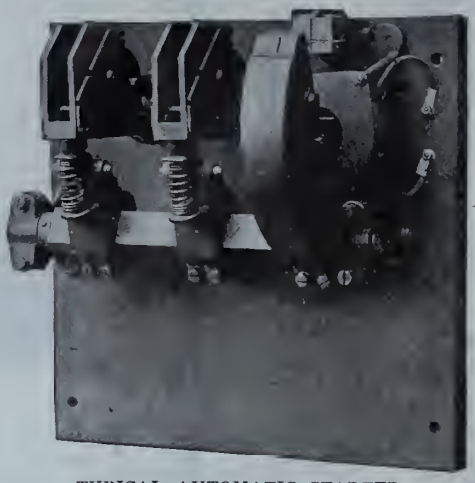
ESTABLISHED 1827

Sole Canadian Representative:

CANADIAN ASBESTOS CO.

Montreal, Que.

When used for pump or compressor service in connection with a float switch or pressure gauge, the action of the starters is entirely automatic, the motors being



TYPICAL AUTOMATIC STARTER EQUIPMENT.

started when the pressure or liquid level of the tank controlled falls to a predetermined point and stopped when the desired maximum pressure or level is reached, or vice versa.

The automatic starters for squirrel cage motors are most frequently employed for starting motors operating centrifugal pumps, air compressors, fans, blowers, metal-working and wood-working machines, and other apparatus requiring starting torque less than full load torque. This type of starter, however, owing to the wide application of squirrel cage motors for industrial service, can be applied economically for starting service in nearly every industry.

Squirrel cage motors of 5 horse-power and smaller are usually connected direct to the line. Large squirrel cage motors are first impressed with low voltage from auto transformers or connected to the line through resistance, so that in

TYPICAL AUTOMATIC STARTER EQUIPMENT.

either case the starting current is reduced. When the speed of the motor has reached such a point that the starting current has decreased sufficiently the motor is then automatically connected to the line.

The automatic starters for wound rotor motors are particularly adaptable for starting motors driving plunger pumps, positive pressure blowers, air compressors, long line shafts, and loads having heavy inertia. The severe starting conditions encountered in this class of service require from 100 to 200 per cent. full load torque in starting, making automatic starting a very desirable feature.

When an automatic starter is used in connection with a wound-rotor motor, the line switch is first closed, with the maximum resistance in the rotor circuit. When the speed falls to a predetermined value, a relay closes a magnetic contactor, which cuts out a part of the resistance in the rotor circuit. Each contactor operates in a similar manner, cutting out its portion of the resistance at the proper time until all the resistance is short circuited by the last contactor.

The power on any circuit may fail suddenly; therefore, it is important that

TYPICAL AUTOMATIC STARTER EQUIPMENT.

some protection be afforded both operator and motor against an unforeseen return of power. This protection may be provided for motors, operating pumps, compressors, etc., by a low-voltage release to disconnect the motor from the line when the voltage is low or power fails entirely; then, as soon as power returns, the motor will automatically start up again. In many applications, however, such as for motors operating metal-working or wood-working machine tools, low voltage protection is required. Motors so protected are disconnected from the line when power fails, and will not start when power comes on again until the operator presses a button or there is no danger from the unexpected starting of a machine.

The advantages resulting from the use of automatic starters for induction motors comprise: absolute protection to both operator and expensive machinery, proper starting at the most rapid permissible rate, economy in operation and maintenance, convenience of remote control, and automatic operation.

Almost every manufacturing process has a certain known temperature at which the best results are produced.

Large sums have been spent experimenting to find this efficient temperature and costly machines and equipment have been installed endeavoring to accurately maintain a proper temperature throughout the manufacturing operation.

Some depend on the thermometer and human intelligence. Others use complicated, indirect-acting apparatus operated by auxiliary power such as electricity, water or compressed air. The most modern and reliable method is to use the

SARCO TEMPERATURE REGULATOR

This regulator is entirely automatic—operating by hydraulic pressure created within itself. It is highly efficient for accurate temperature regulation in tanks or rooms. Quickly and easily installed and requires no auxiliary assistance or attention of any sort.

This regulator follows the fluctuations of the working load and saves the heating or cooling medium. It is small in size and cost; increases the quality of product and reduces operating expenses.

30 DAYS' FREE TRIAL

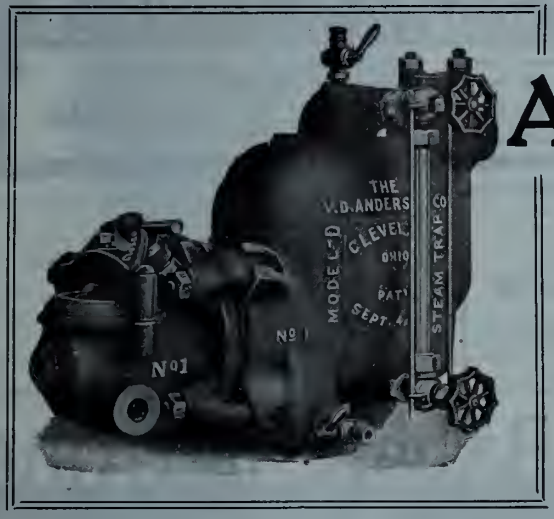
will convince you that all we claim is proven. Write to-day for new illustrated catalogue.

SARCO COMPANY, Inc.

Woolworth Bldg., New York

Branch Offices:

Philadelphia Buffalo Detroit Chicago



Model "D"

Our Catalogue contains full description and excellent data

An Anderson Trap

Wherever condensation troubles are—in the coils, on the exhaust heaters, on the main—there is where an Anderson Trap will prove its efficiency. In ordinary trap uses it will stand out as being distinctly efficient.

It delivers hot, dry steam to the required parts. It is impossible for condensation to gather. Three inches of water seals the valve and seat.

Can be used on any steam apparatus varying from 250 lbs. to gravity. Also where there is condensation in air lines.

We would delight in co-operating with you.

The V. D. Anderson Co.

1935 West 96th Street
Cleveland - Ohio

If any advertisement interests you, tear it out now and place with letters to be answered.

SAVE COAL!

USE

ECONOMIC BOILER COMPOUND

The cry for economy has gone through the land as a war necessity, so why not cut down your COAL CONSUMPTION. If you will send us a piece of scale from your boilers we will analyze same and send you our ECONOMIC BOILER COMPOUND, which we will guarantee to remove the scale from your boilers, or no pay for same.

ECONOMIC BOILER COMPOUND

Manufactured by

Canadian Economic Lubricant Company, Limited
MONTREAL

MacKinnon, Holmes & Co.
LIMITED
Sherbrooke, Quebec

Builders of
Coal Bunkers, Oil Tanks, Water Tanks and Receivers

We specialize in Bridges, Buildings, Towers, Tanks, Penstocks, Roof Trusses, Columns, Smoke Flues and Stacks, Coal Bins, Ore Bins, Buckets, Refuse Burners, Stills, Air Receivers, etc.

Write for Prices

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

WALTER J. FRANCIS, C.E. M. Can. Soc. C.E. M. Am. Soc. C.E. M. Inst. C.E.
FREDERICK B BROWN, M.Sc M. Can. Soc. C.E. Mem. Am. Soc. M.E. Mem. A.I.E.E.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS
Head Office, 232 St. James St., Montreal
Cable Address, "Walfran, Montreal"—W.U. Code.
Long Distance Telephone, Main 5643.

A want ad. in this paper will bring replies from all parts of Canada.

Cameron Babbitt Retainer
(Patented in Canada and the U.S.A.)

Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box.
For any metal.

The only satisfactory compound for retaining molten metal and can be used over and over again for months—no deterioration.
For prices and samples apply to

A.S.K. Chemical Company, Elora, Ontario

WATER SOFTENING OR FILTRATION
FOR BOILER FEED AND ALL INDUSTRIAL USES
WM B SCAIFE & SONS CO PITTSBURGH PA

You see Jefferson is like any good Union up to this point—but

Well, let's go back a bit first—What is it that you engineers have been looking for in a pipe union? Isn't it extraordinary strength that you may make a connection anywhere, above ground or below, and know that whatever happens it's going to stay tight—and yet come off when you want it off, without somebody breaking their back doing it.

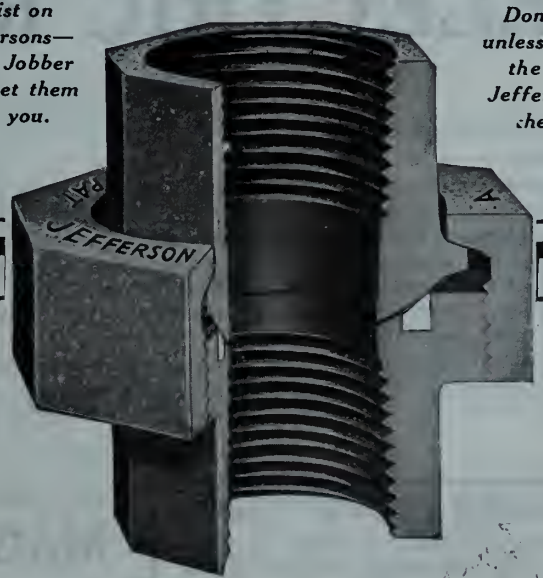
Jefferson Unions

are heavy—the heaviest of their class made. The castings that they are made of are tough. I don't believe there's a wrench made that can chew up their pipe ends or stretch their threads so as to impair their efficiency. Then the threads are coarse and are accurately and deeply cut so the union will set up quickly. So far, the Jefferson is no better than any good honestly-made pipe union—but it's the way that the seat is ground and the seat ring inserted that makes it **distinctly different.** In the first place the seat is ball shaped—it must set up perfectly tight—then the ring is a piece of solid brass tubing which is forced into a recess back from the runway—the joint can't corrode and it can't work loose. But thus—the book I'm holding to mail you tells the whole story. Write for it to-day.

The Jefferson Union Company

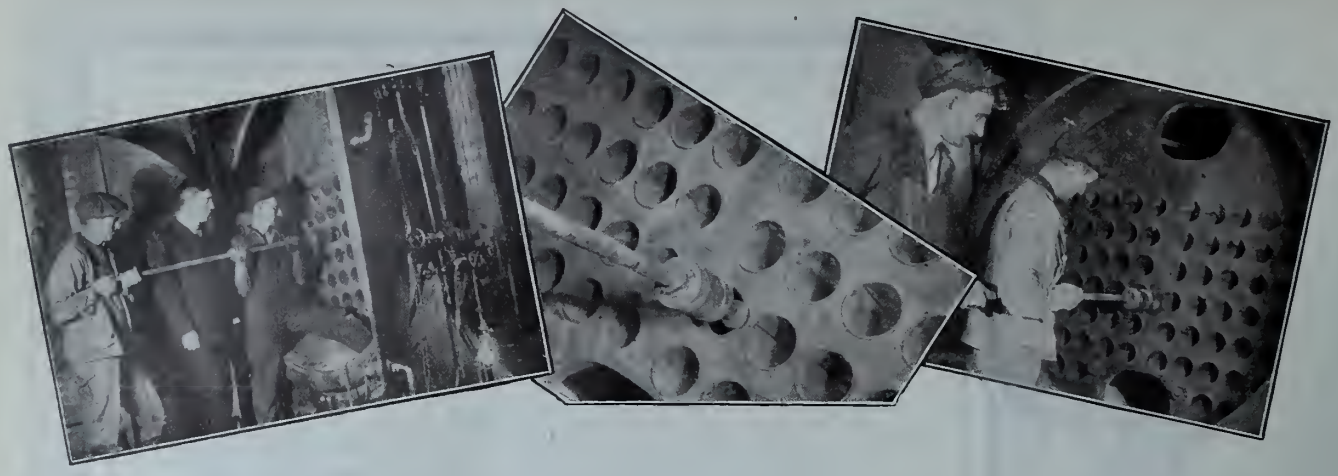
Lexington - - Massachusetts

Insist on Jeffersons—your Jobber will get them for you.



Don't buy unless you see the name Jefferson on the nut.

If any advertisement interests you, tear it out now and place with letters to be answered.



There are many skeptical engineers who won't believe an advertisement, but who will accept the result of an actual demonstration.

We say to those men: "We don't ask you to believe us when we claim, month after month, that the **Dean Boiler Tube Cleaner** will remove scale from your tubes more **thoroughly** than any tool you have ever used.

"We simply ask you to let the **Dean** itself show you what it can do. Give it a trial at our expense. Then, if it doesn't live up to every claim we have made for it, ship it back, and we lose."

To secure the details of our liberal offer, address any of the offices below. Ask for Booklet "Logic of the Dean."

The WILLIAM B. PIERCE COMPANY

153 Ellicott Street, Buffalo, N.Y.

Western Representative:
W. W. HICKS,
567 Banning Street, Winnipeg

201-2 Coristine Building, Montreal, P.Q.

FOR ELECTRIC RAILWAYS

LONDON & LAKE ERIE RAILWAY.

The Magnolia Metal Company. London, Ont., Oct. 6th, 1916.

Gentlemen:—

It affords me much pleasure to testify to the merits of your product.

Have used it continually for four years, and, as stated to your Mr. Peck, found it most satisfactory, both as to quality and service.

We have not in the period named had a single hot journal or bearing, and as our cars run at times over 40 miles per hour, we think this is a record.

One thing is certain, if the man who uses the metal does his work properly, no fear may be entertained that it will fail.

I have no hesitation in giving you this testimonial, which is deserved.

Yours truly,
W. N. WARBURTON,
General Manager.

PRACTICAL ENGINEER POCKET BOOK:
Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY

MAGNOLIA METAL CO.

OFFICE AND FACTORY:
225 St. Ambroise St. MONTREAL

Mention this paper when writing advertisers. It will identify the proposition about which you require information.

Garlock High-Pressure Piston Rod Packing

Style No. 200.

Is built up on a core consisting of several flattened tubes.

The tubes are braided from the highest grade of asbestos yarn, and are cemented together with the best rubber friction.

The tubes are cemented only on the outside, therefore the packing is lighter per linear foot than other types of high-pressure packing.

In service the tubes open under pressure and expand the packing against the piston rod.

The core of flattened tubes is backed with a cushion of high-grade rubber, so compounded as to retain its resiliency under heat.

The tube-core and rubber cushions are covered with cloth woven from the highest grade of long fibre asbestos.

Our high-pressure packing is not merely smeared on the outside with graphite and grease.

Every fibre of it is saturated with a specially prepared lubricant, which does not affect the rubber cushion or friction.

The outside of the packing is coated with the best grade of floating stock graphite.

The best materials we can buy are used in the manufacture of our high-pressure packing.

It is built up in rectangular form and uniform shape and exact sizes are thereby obtained.

Asbestos packing, which is rolled around a rubber core and afterwards distorted by running through a square die, does not retain its shape or size.

Our high-pressure packing is made by experts who have done nothing else for years but make that one type of packing.

The length of service obtained from it is greater than that secured from other makes, therefore the labor cost of applying and adjusting is less.

Our packings are sold at net weights; weights of tubes and boxes are not included.

Every pound of our high-pressure packing carries with it the Garlock guarantee of satisfactory and economical service.

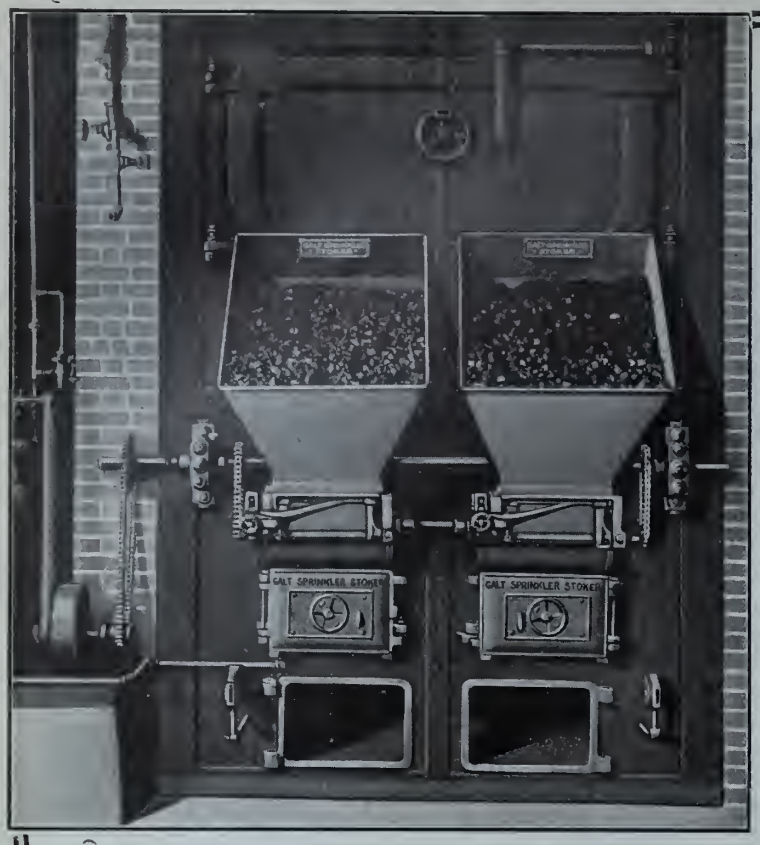
We will promptly replace or refund the cost of any of our packings which may prove unsatisfactory to our customers.

The Garlock Packing Company - Hamilton, Ont.

Branches:

Montreal, Quebec - - - 409 Shaughnessy Bldg.
Toronto, Ontario - - - Continental Life Building
Winnipeg, Manitoba - - - - - Galt Building

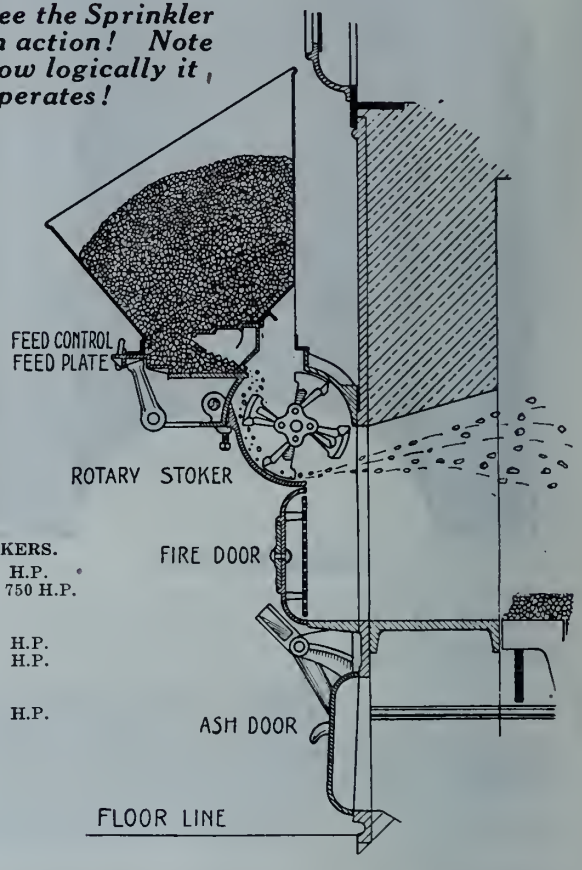
If any advertisement interests you, tear it out now and place with letters to be answered.



Two Types "A" Galt Sprink'er Stokers applied to 150 H.P. Return Tubular Boiler. (Coal Hoppers immediately removable.)

GALT SPRINKLER STOKERS

See the Sprinkler in action! Note how logically it operates!



PARTIAL LIST OF RECENT CONTRACTS FOR "GALT" SPRINKLER STOKERS.

"B"	—T. Eaton Co., Limited, Winnipeg	12 stokers	1,600 H.P.
"A," "B"	— " " Toronto	3 "	1 boiler, 750 H.P.
"B"	—Hinde & Dauch Paper Co., Toronto	8 "	
"A," "C"	—Spanish River Pulp & Paper Co., Sturgeon Falls, Ont.	8 "	1,200 H.P.
"A," "C"	—The Dryden Pulp & Paper Co., Dryden, Ont.	12 "	1,200 H.P.
"A"	—The Hamilton Cotton Co., Hamilton, Ont.	6 "	
	The Board of Education, Hamilton, Ont.	2 "	
"B"	—City of Winnipeg General Hospital, Winnipeg.	8 "	1,000 H.P.
	P. Burns & Co., Vancouver, B.C.	6 "	
"A," "B"	—Messrs. Gordon, Ironside & Fares, Winnipeg.	3 "	
"D"	—Corporation of Vegreville, Alta.	4 "	
"B"	—The Dominion Oil Cloth Co., Montreal	2 "	
	The Dominion Power & Transmission Co., Hamilton	4 "	
	The Lister Chambers, Hamilton, Ont.	4 "	

"A" —Repeat order.
"B" —The fuel utilized is a mixture of 80% anthracite dust with 20% of bituminous slack, using under grate forced draft.
"C" —Burning bituminous slack with induced draft.
"D" —Burning lignite slack with natural draft.
"E" —Others on the above list are burning bituminous slack with natural draft.

The Stoker mechanically feeds and perfectly spreads the fuel over the entire length and width of your present grates with the fire doors closed in a light, continuous, uniform stream.

We supply Power-Turbo Blowers, McNaughton Rocking Grates, Damper Regulators and other Power Plant Equipment. Send for illustrated catalogs.

THE GALT FOUNDRY COMPANY, GALT, ONT.

ALBERTA
W. J. Yeo & Co., 210 McLeod Block, Edmonton

MONTREAL
Ross & Greig, 421 St. James Street

HAMILTON
D. Turner, 110 Lister Chambers

Ontario Representative:
J. M. Allen, 65 Bloor St. W., Toronto, Ont.
Eastern Representative:
Wm. Reid, 27 Celebration St.,
St. John, N.B.

Plibrico — Endorsed by some of the leading Engineers as the Greatest Furnace Lining of Recent Times

PLIBRICO—makes a solid one-piece lining without joints. Absolutely gas and air-tight. Saves its cost in fuel in a month or two—you will have a steady fire with less effort and less coal by using it.

PLIBRICO—is mixed ready for use, requires only half the time to install and does not require skilled labor. Any laborer who is at all familiar with the building line can use it. DOES NOT BREAK, CRACK OR SHELL OFF LIKE ORDINARY BRICK.

Can be used for front door arches, side walls, bridge walls, combustion chamber and rear arches. A highly refractory, plastic, one-piece furnace lining for boilers, baffles, Dutch oven construction, cupolas, retorts, enamelling furnaces, gas and oil-fired furnaces, and wherever a high-grade fire brick is required. Sets quickly—after a few hours with a low fire to draw off the moisture, you may fire up as usual. No special forms required.

Ideal for temporary repairs. Better order a barrel and have it ready for an emergency.

PLIBRICO BOND—A high temperature cement for repairs

"PLIBRICO BOND" is a product which gives a perfect bond between fire-brick, and does not allow the fire to burn out the joints, as is the case where fire-clay is used. Prevents furnace walls from cracking and crumbling.

It's the most practical and logical high temperature mortar you can use. It's the ever-ready repair cement that you should have in case of emergency.

Canadian Sales Agents Beveridge Paper Company, Ltd., Montreal, P.Q.

DART

DART

At the Joint They Are Bronze

Can rust or corrosion set in where bronze touches bronze? What is the value of a ball-shaped seat at the joint? Dart Unions have these features in their make-up. That is why they make and hold so many friends.

The bronze joint will not rust or corrode. The ball-shaped seat allows an easy connection regardless of the alignment.

Installed, the Dart Unions give wonderful service. They are made to do that.

Inquire of your dealer.

DART UNION COMPANY, LTD.

TORONTO ONTARIO CANADA

If any advertisement interests you, tear it out now and place with letters to be answered.

"McAVITY"
IXL
AUTOMATIC RE-STARTING
INJECTOR

The Best and Most Economical Automatic Injector on the Market

These "IXL" Injectors have increased areas where cones fit in body, enabling them to do more work and give better satisfaction than any other automatic single tube Injector.

EVERY INJECTOR TESTED
Price List upon Application

T. McAVITY & SONS
LIMITED
St. John, N.B., Canada
Montreal Winnipeg

Davis Pressure Regulators Save Steam

Don't Waste Steam

You carry high boiler pressure for emergencies and peak loads, but are you sure this reserve is not slipping away? You know only too well the cost of coal—conserve it by keeping your steam pressure under full control with

DAVIS PRESSURE REGULATORS

Put these automatic valves to work wherever you can use less than boiler pressure. The cost is trifling and the saving big. Forty years on the market is enough to prove they are built right. Send for catalog. It will show you a way to cut costs.

G. M. DAVIS REGULATOR CO.
434 Milwaukee Avenue
Chicago - - - Illinois

Mechanical Regulation of Boiler Feed Water

By the use of the "S-C" method you are assured of a continuous feed at all times load is on boiler. The graduation in rate of feeding is entirely dependent upon the load and fire conditions. The Regulator will carry a constant level on steady load—higher level on light load and lower level on peak loads. Variation in water level is entirely dependent on inclined position of generator which is adjustable while operating under full load.

Bulletin No. 80 explains all.

Generator or Actuating end of Regulator.

Regulating Valve Placed at Any Point, Any Position.

The "S-C" Regulator Company
Feed Water Regulation Engineers
FOSTORIA, OHIO, U.S.A.

Representatives for Eastern Canada: MacLean & Barker, Southam Bldg., Montreal.

LUNKENHEIMER

Oil and Grease Cups

Perfect Working, Durable and Reliable Devices for Use on Engine and Transmission Bearings.

Second only to the Lubricant used, the importance of an Oil or Grease Cup on a bearing is evident,—the very life of the unit depending on an uninterrupted flow of lubricant to the bearing surfaces. Therefore, the selection of Oil and Grease Cups should be governed by their Reliability and Durability. These are the governing factors in the design and manufacture of Lunkenheimer Cups; a fact proved by the years of satisfactory service which they give. The variety of designs made covers every possible requirement.

Specify and insist on having power and transmission bearings equipped with Lunkenheimer Cups, and satisfactory service is a certainty.

Write for Booklets Nos. 523 and 524.

THE LUNKENHEIMER CO.
"QUALITY"
Largest Manufacturers of High-Grade Engineering Specialties in the World
New York Chicago CINCINNATI Boston London

23-43

Detroit Lubricators

Have Given Satisfaction For Forty Years.

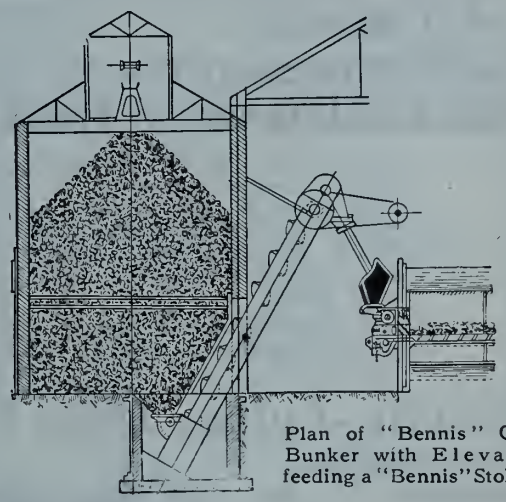
Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.



Plan of "Bennis" Coal Bunker with Elevator feeding a "Bennis" Stoker.

Plants similar to the above have been installed in many of the new National Factories to ensure maximum output and rapid and efficient handling with the minimum of labour. "Bennis" Conveyors and Elevators are indispensable for the cheap and efficient transport of material in bulk. Schemes prepared to any requirements.

Write to-day for descriptive literature.

ED. BENNIS & CO., LTD.

Little Hulton, Bolton; 28 Victoria Street, S.W. London, Eng.

If any advertisement interests you, tear it out now and place with letters to be answered.

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

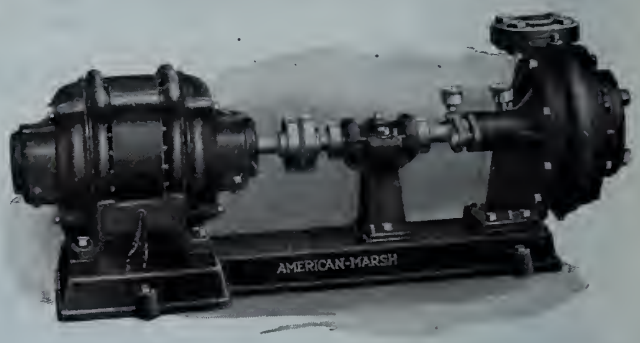
This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

CANADIAN AGENTS

A. R. Williams Machinery Co., Toronto.
Williams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company
Battle Creek, Mich.



American-Marsh Centrifugal Pump.

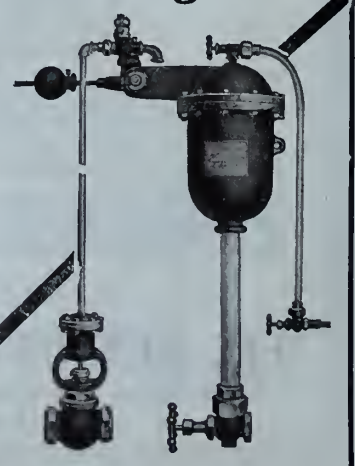
Instal now a positive preventive of high and low water troubles

The Vigilant Feed Water Regulator, by keeping the water level within ¼" of middle gauge, gives you this absolute protection. And besides this, the middle gauge means efficient steaming with reduced boiler repairs and fuel saving of 3 to 17% (by actual record).

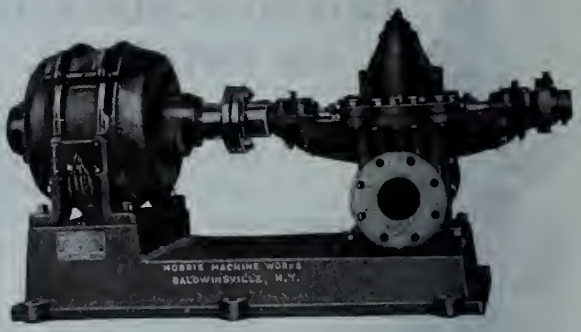
Don't continue to take chances with the old hand-regulated method, instal the Vigilant now.

Chaplin-Fulton Mfg. Co.
28-34 Penn Ave.,
Pittsburgh, Pa.

We'll be glad to send you a useful set of engineers' data cards and our catalog upon request.



Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2" to 20" discharge.

Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.
Builders of Centrifugal Pumps, Hydraulic Dredges, Steam Engines

Canadian Sales Agents:
Storey Pump & Equipment Co., Toronto, Can.

ALBANY GREASE

should be used on every bearing in your plant from the main bearings of your engine to the last bearing on your line shafting—always. Albany Grease will give you efficient lubrication service at the lowest possible cost. We'll gladly send you an Albany Cup and a quantity of Albany Grease for trial. No charge of course. Why not write us now?

Albany Lubricating Co.

708-10 Washington Street - New York

ESTABLISHED 1868

6 F TYPE OIL FILTERING AND CIRCULATING SYSTEM

Conservation of POWER

With the

BOWSER ESTABLISHED 1885

Oil Circulating *and* Filtering System

Improper lubrication causes friction
To overcome friction and carry the power house load, extra power is used.
The Bowser System stops this waste of power by providing an unvarying supply of oil for the bearings at all times.
You can see how Bowser will save for you—save power, save shutdowns, save repairs, add to the life of your machinery, increase your production.

Bowser Engineering Department at your Service.

S. F. Bowser & Co., Inc.

Toronto, Ont.

Sales Offices in all Centres *Representatives Everywhere*

GAUGES

How Do!!

To-day I am going to talk GAUGES

Do you know we handle the most complete line of gauges imaginable? Yes! it's a fact. Every type of Gauge for measuring any pressure, vacuum or draft. Also Gauge Testers. But here's the line in a nutshell.

Steam Gauges, Vacuum Gauges, Ammonia Gauges, Mercurial Barometer, Gauge Testers, Test Gauges, U Gauges, Mercury Pressure and Vacuum Gauges, "Redline" Differential Draft Gauges.

Keep this in mind when in the market or, better still, get our Catalog Sections P.H. 1-50-75-for your file. Good-bye; see you next month.

The Schaeffer & Budenberg Mfg. Co.

BROOKLYN, N.Y.

Chicago, St. Louis, Pittsburgh, Washington, Philadelphia

ALSO

Recording Gauges
Recording Thermometers
Thermometers
Tachometers
Counters
Calorimeters
Etc.. Etc.

Put These Tools in Your Kit

You use a Speed Indicator frequently, a micrometer seldom, but you need both to maintain your standards of accuracy.

Match every need for correct measurements with

Starrett Tools

Some of the tools that especially fit your needs are Ratchet Wrenches, Hack Saws, Steel Tapes, Calipers and Rules.

Ask for Catalog No. 21CD, describing the many styles and sizes.

The L. S. Starrett Co.

The World's Greatest Toolmakers

ATHOL
Mass.

42-708

If any advertisement interests you, tear it out now and place with letters to be answered.

D. K. McLaren's Belting

Used by Leading Power House Plants

MORE POWER

Discard Ordinary Belting and Use D. K. McLaren's

Belting that repeatedly breaks, stretches and fails to grip the pulley every minute of the day is ordinary belting. It's losing you money in lost power and lost power is very expensive in these days of advancing fuel prices.

To make certain of getting the most for your money you should use McLaren's Belting. With it you are assured of every bit of power.

There's not a leather belt that will not slip a little, also break at some time, BUT with D. K. McLaren's belting you get a minimum amount of slipping and fewest number of breaks.

Our highly scientific method of manufacturing is the secret of our belt excellence. It includes the famous—

British Oak Tanning Process

This method, coupled with the selection of the best hide-centres, gives the leather mighty strength and durability.

Look for "Oak Leaf" Trade Mark on all our belting.

D·K·McLAREN LIMITED

Like to put you in touch with users.

MONTREAL 351 St. James Street

ST. JOHN, N.B. 90 Germain Street

TORONTO 194 King Street West

VANCOUVER 847 Beatty Street

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED.

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

STRONG STEAM TRAPS

The cheapest trap on the market when actual capacitities under similar conditions are considered.

Hundreds of these traps all over Canada are giving excellent satisfaction.

Repeat orders from users of Strong Traps is a sufficient indication of their merits.

The convenience of inspection and adjustment without disconnecting from the Pipe line will commend them to every engineer.

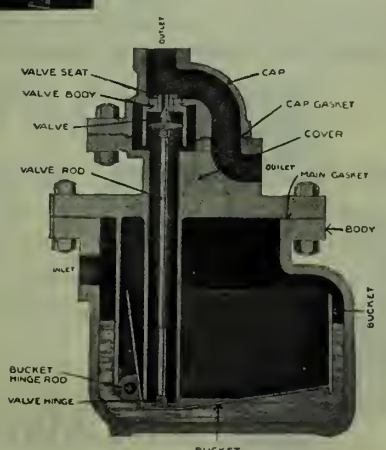
Specify Strong Traps on your next order. Full information and prices on request.

THE CANADIAN FAIRBANKS-MORSE CO., LIMITED

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

At the left are shown 3 of many traps installed in the Sherbrooke High School.

Below is a cross section of the Strong Trap.



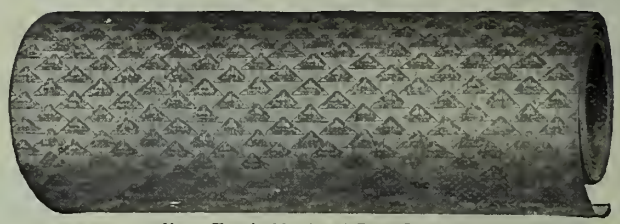
THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

DURABLA

DURABLA
TRADE MARK REGISTERED

ASBESTOS SHEET PACKING

DURABLA
TRADE MARK REGISTERED
Reg. Trade Mark



Note Trade Mark All Over Sheet

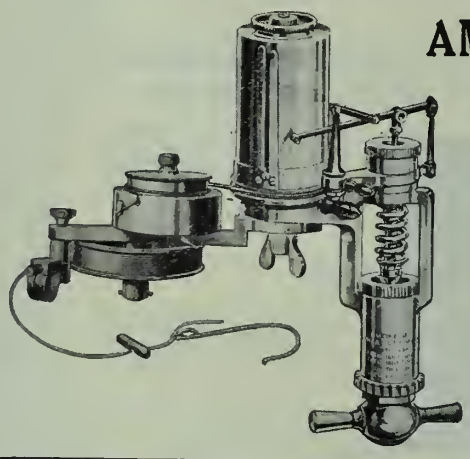
DURABLA
TRADE MARK REGISTERED
Reg. Trade Mark

Guaranteed to make a Tight Joint
Wherever a Permanent Gasket is Required

Sold on a Service Basis Only. *Test it and Prove our Claim.*

DURABLA MANUFACTURING COMPANY

NEW YORK PITTSBURGH PHILADELPHIA



AMERICAN-THOMPSON IMPROVED INDICATOR

WITH

DETENT MOTION AND IDEAL REDUCING WHEEL

The most UP-TO-DATE and SUBSTANTIAL Indicating Outfit on the market.

Every Engineer should own one.

Our Instalment Plan of Payment makes this easily possible.

Ask our nearest office for details.

Sole Agents for Canada: CANADIAN FAIRBANKS-MORSE CO., LTD., Montreal, Toronto, Winnipeg, Calgary, St. John, Quebec.

AMERICAN STEAM GAUGE & VALVE MFG. CO.

New York Chicago BOSTON Atlanta Pittsburgh

WASTE IS WICKED; STOP IT

MARTELL PACKINGS MEAN MORE POWER

YOU KNOW that every pound of flax, rubber or asbestos put in engine stuffing box is ab-so-lute-ly wasted.

SURE; it's buy, buy, buy all the time, and YOU not only waste material, YOU waste power and YOU waste time.

START TO STOP this waste to-day, NOW, not to-morrow, by asking us for demonstration free.

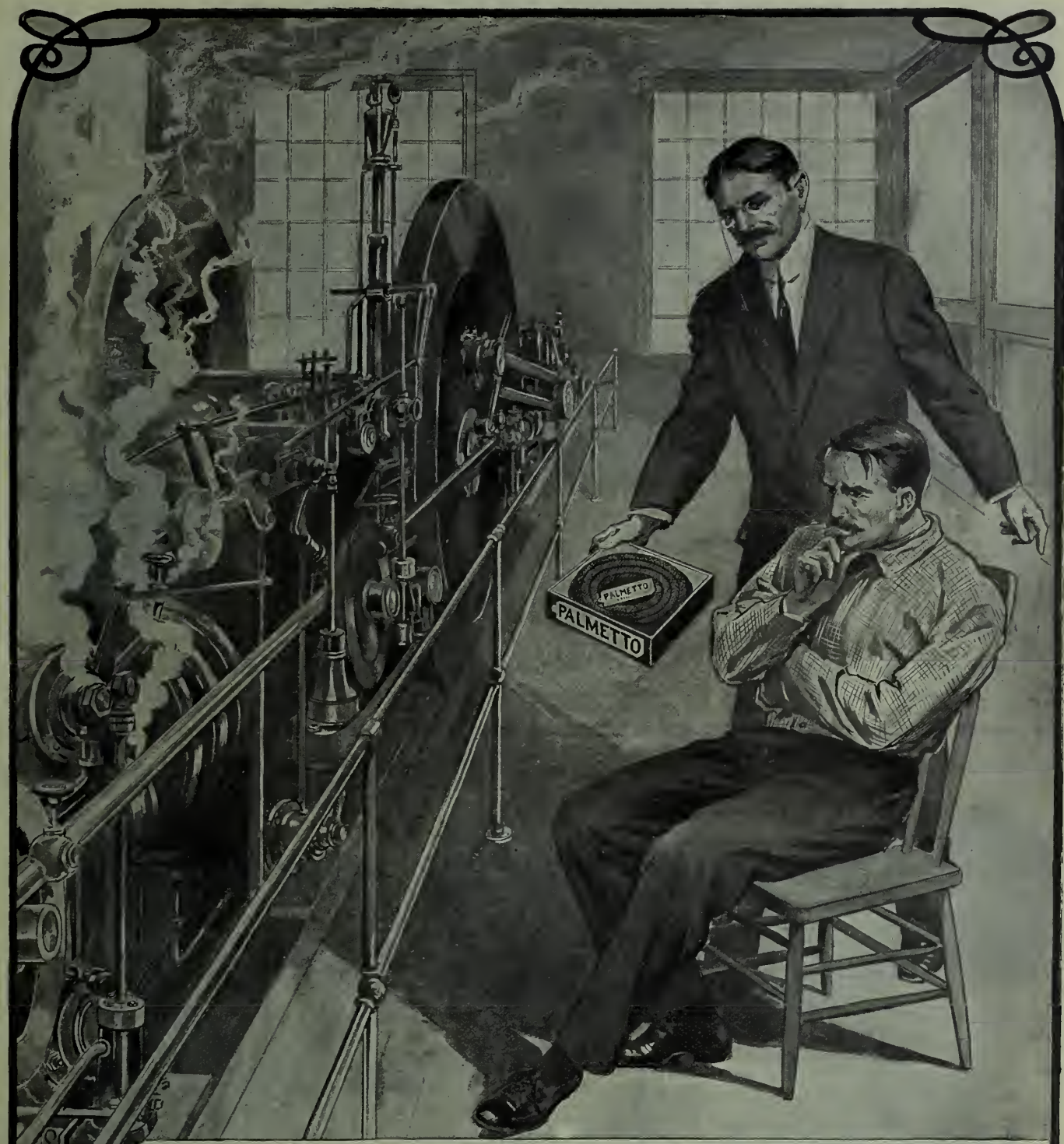
"We make a METAL packing for every purpose."

The Martell Packings Co., Inc. ELYRIA OHIO

Canadian Agents: The CANADIAN FAIRBANKS-MORSE CO., Limited

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS



SAVE YOURSELF THE WORRY of leaky stuffing-boxes by using

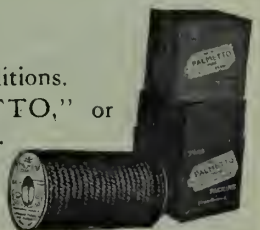
TRADE MARK

"PALMETTO"

REG U S PAT OFFICE

a packing made to give long service even under hard conditions.

ASK THE ENGINEER WHO USES "PALMETTO," or let us send you working samples to test. No Charge.



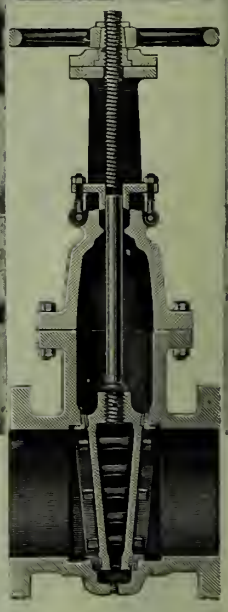
Greene, Tweed & Company

Sole Manufacturers, 109 Duane Street, New York

Representatives in Canada: THE CANADIAN FAIRBANKS-MORSE CO., LTD.

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS



Piping installation at Low Level Pumping Station, Montreal. Valves marked indicate Pratt & Cady Semi-steel Valves on superheated steam line having temperature of 150 degrees per lb. of inch. 12" line to the main pumping units.

There's no service that the highly efficient range of Pratt & Cady Valves do not fully meet. Fifty years in use.

Easily operated. Take pressure from either side without wedging, and seat ring is easily renewed without removing valves from pipe line.

Manufactured by
PRATT & CADY, Inc.
Hartford, Conn., U.S.A.

Canadian Sales Agents:
The Canadian Fairbanks-Morse Company, Limited

St. John	Quebec	Montreal	Ottawa	Toronto	Hamilton
Windsor	Winnipeg	Saskatoon	Calgary	Vancouver	Victoria

Multi Head Heater

An Economizer—

Here's Why

Alberger Heater Co.

BUFFALO, N.Y., U.S.A.

GENERAL SALES AGENTS:

Canadian Fairbanks-Morse Co., Limited

St. John	Calgary
Montreal	Saskatoon
Ottawa	Windsor
Toronto	Vancouver
Hamilton	Winnipeg
Quebec	Victoria

The Double Floating Head eliminates the danger of expansion strains; they are in sections so as to differentiate between expanding and contracting of tubes of different temperatures.

The Helical Spiral Corrugation gives the water a whirl, keeping tubes clean and free from scale. By this method a gain of 50% in heat units is made.

Corrugated Copper Tubes eliminate formation of scale and prevent splitting (common in brass tubes).

Plants of all sizes are finding the Alberger a daily economizer and efficiency promoting heater. Full details will gladly be given upon request by our agents or ourselves.

SKF

Repeat Orders—The Acid Test

Repeat orders are the acid test of a product. No man buys a second time unless he has found a satisfactory product.

In September, 1915, the Colt's Patent Fire Arms Manufacturing Company bought 50 SKF Ball Bearing Hangers—as a trial installation. After a year's trial they bought 400 additional SKF Hangers.

But this is not all. In January, 1917, they bought 200, and in May, 1917, about 500 SKF Hangers, making a total of over 1,000 SKF Hangers.

This is satisfaction—SKF satisfaction—and repeat orders are the proof. Our Hanger Catalog No. 78 will give you further proof. Send for it.

CANADIAN SKF CO., LIMITED
TORONTO, CANADA

Sole Canadian Agents SKF Transmission Bearings

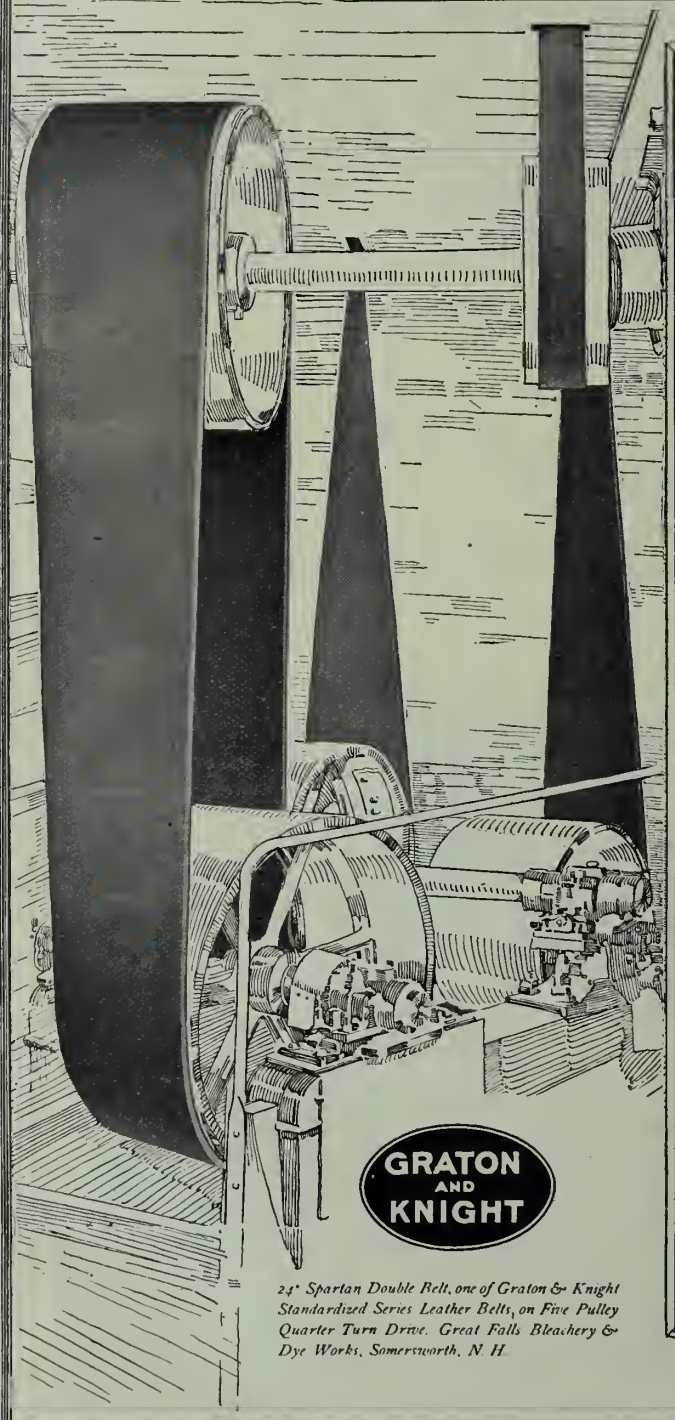
The Canadian Fairbanks-Morse Co., Limited

St. John, Windsor, Quebec, Winnipeg, Montreal, Saskatoon, Ottawa, Calgary, Toronto, Vancouver, Hamilton, Victoria

GRATON & KNIGHT

Standardized Series LEATHER BELTING

Tanned by us for belting use



24" Spartan Double Belt, one of Graton & Knight Standardized Series Leather Belts, on Five Pulley Quarter Turn Drive. Great Falls Bleachery & Dye Works, Somersworth, N. H.

It Begins in the Tannery

Leather is the Standard Belting Material

To us, the largest belting makers in the world, every possible belting material lies open for selection and use. But the belting experience of generations points to the unescapable fact that leather has the properties necessary to make good belting.

Leather that is properly tanned for belting is tough, flexible, durable and prehensile. It preserves the natural softness and mobility of the skin, ensuring an effective grip on the pulley surface.

We have standardized these requirements of perfectly tanned belt leather. The standard in each case is the highest *working* efficiency in the finished belt.

Since the market cannot supply tanned belt leather that continuously measures up to Graton & Knight Standards, we tan our own hides. Last year, we tanned 285,000 of them, in our own tannery. We tanned them for *belts*. We tanned them to definite and uniform standards of belting requirements.

This standardization of material is the foundation of Graton & Knight quality.

It makes the Standardization of Graton & Knight Belts an actual, practical thing.

Think what other standardized products have done for you—and consider the standardization of belting on that basis. Let us send you complete information on the subject.

THE GRATON & KNIGHT MFG. COMPANY

Oak Leather Tanners, and Makers of Leather Belting

Worcester, Massachusetts, U.S.A.

Canadian Representatives: The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Saskatoon, Windsor, Vancouver, Winnipeg, Victoria.

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

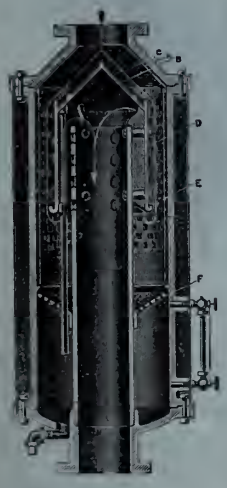
Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

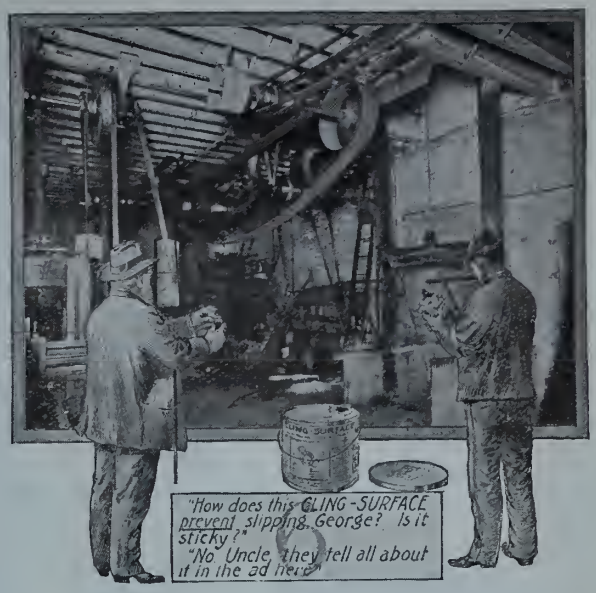
DIRECT SEPARATOR COMPANY

820 Geddes Street · SYRACUSE, N.Y.

General Sales Agents:

Canadian Fairbanks Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



WHEN "Mike" spits on his hands he does a very natural thing. The tool is slipping because his hands are hard and slippery. Of course he could hold it tighter, but it's easier to soften up the skin. So "Mike" spits on his hands.

We looked at the belt problem this way more than twenty years ago. A leather belt and the palm of the hand are not so very different. Both are skin—one's thicker than the other, that's about all.

The leather is a growth of millions of separate fibres, and is porous. Unlike the hand, it has no life of itself—no natural oils to moisten it—but must be kept mellow and pliable.

A grease should be worked into the belt, where it can surround each fibre and lubricate it from its fellows. Thus they will "run in grease" and slide easily as the belt bends, instead of grating harshly together. The belt becomes pliable and mellow instead of dry and harsh. The surface of the belt will be clean, yielding, "velvety," yet not sticky, and will COHERE with the pulley faces.

Now, any grease so used has got to be a real preservative food, with no harmful acids, and should not oxidize, turn rancid, form sediment, or become stringy. Rosin and rosin oil is condemned by all belting authorities, and various vegetable and mineral oils, in their natural state, cause cracking or rotting within the belt and eventually destroy it.

Sticky belt dressings, while they stop the slipping for a time, are about as bad as glue upon the hands, and for the same reasons.

CLING-SURFACE is a real preservative treatment.

A CLING-SURFACE treated belt will run perfectly in all weathers, easy or slack under big overload, without slipping. It will not warp, tear at the laces, separate at the joints or gather static electricity. With CLING-SURFACE the life of the belt is prolonged, and its capacity for work greatly increased. It immediately becomes a cheerful, obedient worker, soon needing little or no attention, take-up or protection other than the occasional treatment with CLING-SURFACE, and always working easily, silently and efficiently.

CLING-SURFACE can be applied to your belts by any workman in a few hours. A treatment now means a definite step toward permanent freedom from all belt trouble, and money in your pocket, with practically no effort to put it there.

Our co-operation will assist you in this work. Let us send you a can for sixty days' trial.

Remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface Co.

1057 Niagara Street

Buffalo New York

If any advertisement interests you, tear it out now and place with letters to be answered.

"Maple Leaf" Brand

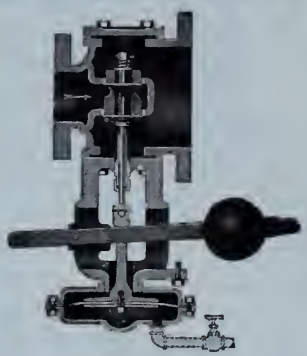
Stitched Cotton Duck Belting

THE BEST FOR ALL KINDS OF BELTS

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.

Dominion Belting Co., Ltd.,
HAMILTON, CANADA



SPECIAL 98
VACUUM PRESSURE
REGULATING VALVE

THERE IS A

Kieley & Mueller

Regulating Valve for Every Service

The valve illustrated above is specially designed for use with vacuum or vapor heating systems—initial pressure 150 lbs. or less—reduced pressure 0 to 10 lbs.

SALES ENGINEERS

THE ARTHUR S. LEITCH CO.
TORONTO

Speed Up—

IN War Times you should get all the speed out of your machines possible.

You can do this by using BOND Hangers. From the day you put a BOND Hanger on the job it starts saving your oil, your power, and your patience.

It is an investment that yields a steady return with every revolution of your shafting.

The sturdy, braced construction makes for smooth running without vibration. Its design permits full accessibility for adjustments or erection.

The Bond Hanger Book tells about everything we make in the line of power appliances.

Your files are not complete without it.

CANADIAN BOND HANGER & COUPLING CO.
Limited
ALEXANDRIA ONTARIO

The "Rocker-Joint"
Depends Upon Its Construction,
not Upon Lubricant,
for Its Life and Efficiency

POWER TRANSMISSION

What does she know about it? Not a thing! But she knows that he knows, and that's the point. He is a long-time user of silent chains and what he says about them counts. This is what he says:

"There is *only one SILENT CHAIN* with a properly designed joint, and that is the MORSE. The 'ROCKER JOINT,' the exclusive, patented feature of the MORSE, eliminates all power losses because it permits *no destructive sliding friction,* as do other joints. There is only the simple movement of the rocking-chair."

Flexible—Positive—Efficient

MORSE CHAIN CO., Ithaca N.Y.
Largest Manufacturers of Silent Chains in the World

MORSE SILENT CHAINS

If any advertisement interests you, tear it out now and place with letters to be answered.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressnre of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL M. A., PH. D., Superintendent, Trades & Labour Branch.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

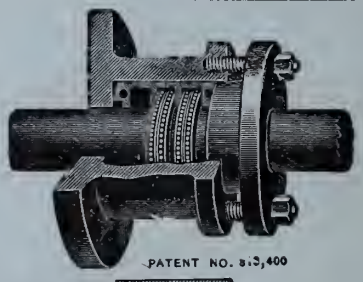
MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.

THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



PATENT NO. 8:3,400

PAT. NO. 436,177
" " 500,696
" " 584,104
" " 602,828
PAT. NO. 654,841
" " 654,542
" " 725,866

Why not Buy the Best, when in market for Packing?

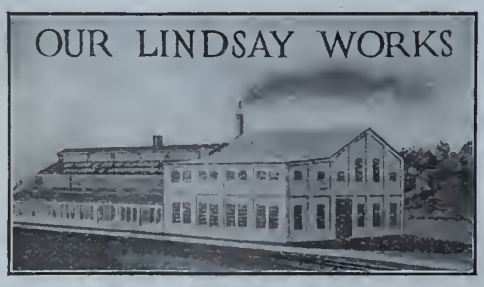
HOLMES' Metallic Packing

is Guaranteed 3 years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

Holmes Metallic Packing Co., Wilkes-Barre, Pa.

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
LINDSAY, ONTARIO

THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa.

Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

THOMAS ELLIPTIC GRATE BARS— SHAKING CIRCLE STATIONARY

Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

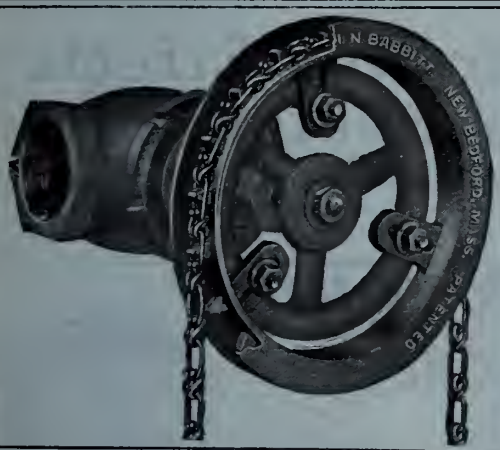
More Dollars

You can make "Dollars Grow" out of your *spare time*. Spare-time efforts have made hundreds of dollars for MacLean Representatives. To-day there are in Canada, men and women, who find that our proposition worked for an hour or two daily provides for many of the added luxuries of life. You supply us the time,—we'll supply you the money. Write for full particulars.

The MacLean Publishing Co., Limited
Dept. M, 143-153 University Avenue, Toronto, Can.

High-Class Pumps for Every Service

The Smart-Turner Machine Co., Ltd.
Hamilton, Canada



They Thought TWO Would Do

in a certain big New England mill, because mill and equipment were brand new and strictly modern.

But They've Bought Just 27 of These

Babbitt Adjustable Sprocket Rims

since July 1st. Like this: July 1, two; July 20, two; July 23, six; Aug. 25, eight; Sept. 8, nine. That's the way they go, because everybody recognizes them on sight, as "Just the thing they have been looking for, but did not know where to get it." Easy to put on—goes right on your present valve wheel—easy to pay for. Ask your dealer. Send for Illustrated folder.

BABBITT STEAM SPECIALTY COMPANY
59 So. Water Street NEW BEDFORD, MASS.

Self-Lubricating

In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

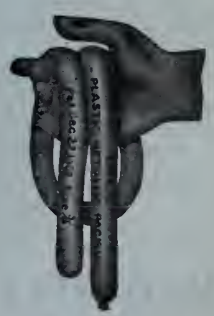
GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

Practically Frictionless



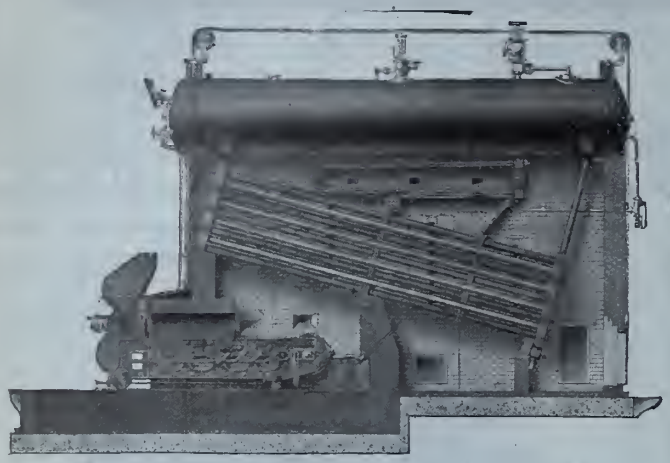
In Cotton Tubes

If any advertisement interests you, tear it out now and place with letters to be answered.

"ALL BRITISH"

"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 16,000,000 H.P. IN USE



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

Our Book "STEAM" sent on request

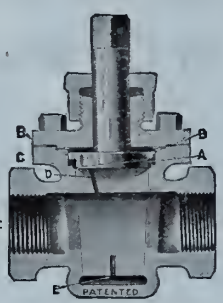
BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL

TORONTO OFFICE, TRADERS BANK BUILDING

Leak Proof

Positive Action



Simple Design

Durable Construction

Look at it This Way

Homestead Quarter-Turn Valves pay for themselves by eliminating all wastes and leakages.

Being sealed at the top and bottom, the "Homestead" is guaranteed against leakage. Being seatless while the pressure is passing through, it lasts several times as long as the ordinary valve.

Look at it any other way—

A Homestead Valve pays handsome dividends from year to year and renders dependable and efficient service.

Write us for more information.

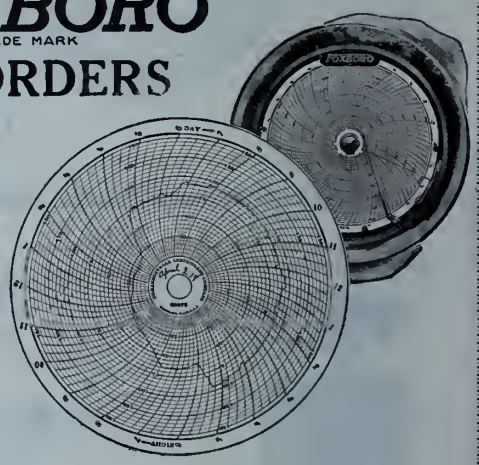
Homestead Valve Mfg. Co.

Works: Homestead, Pa.; Pittsburgh, Pa.

Vibration Effects Are Minimized—

The use of a carefully supported helical tube actuating device, operating a short pen arm, minimizes the effects of vibration in

FOXBORO
TRADE MARK
RECORDERS



Every detail is designed for accuracy and strength. Absolutely "Dead Beat" and Non-corrosive.

Furnish clear, easily legible *Pressure, Temperature, Flow or Speed* chart records.

WRITE FOR BULLETIN NO. E-90.

Large Stocks carried in Canada by

PEACOCK BROTHERS : : MONTREAL

Manufactured by

THE FOXBORO CO., Inc., FOXBORO, MASS., U.S.A.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

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Penberthy Injector Co., Windsor, Ont.

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Bellis & Morcom, Birmingham, Eng.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

AIR RECEIVERS
MacKinnon, Holmes & Co., Sherbrooke, Que.

AMMETERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
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AMMONIA VALVES AND FITTINGS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Homestead Valve Mfg. Co., Pittsburgh, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

AMMONIA TANKS
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
Canadian Fairbanks-Morse Co., Ltd., Montreal.

ASH CARRYING SYSTEMS
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

ASBESTOS SPECIALTIES
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.

AUTOMATIC ICE RECORDING DOORS AND CHUTES
Jamison Cold Storage Door Co., Hagerstown, Md.

BABBITT AND ANTI-FRICTION METAL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. B. K. Morton Co., Toronto, Montreal.
Hoyt Metal Co., Toronto.
Magnolia Metal Co., Montreal.

BABBITT RETAINER
A. S. K. Chemical Co., Elora, Ont.

BALL BEARINGS
Can. S K F Co., Toronto, Ont.

BALLCOCKS
D'Este Co., Julian, Boston, Mass.

BATTERIES AND ACCESSORIES
Can. H. W. Johns-Manville Co., Toronto, Ont.

BELT CEMENT
Graton & Knight Mfg. Co., Montreal.

BELT DRESSING
Cling Surface Co., Buffalo.
Jos. Dixon Crucible Co., Jersey City.
Dominion Belting Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.

BELT LACING, LEATHER
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
American Pulley Co., Philadelphia, Pa.
Waterous Engine Works Co., Brantford, Ont.

BELTING, BALATA
Can. B. K. Morton Co., Montreal.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. B. K. Morton Co., Toronto, Montreal.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren, Ltd., Montreal.

BELTING, RUBBER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Jeffrey Manufacturing Co., Montreal.
Peerless Mfg. Co., New York, N.Y.

BINS, COAL, COKE AND ORE
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

BLOWERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Coppus Eng. & Equip. Co., Worcester, Mass.
Green Fuel Economizer Co., New York, N.Y.
Sturtevant Co. of Canada, Ltd., B. F., Galt, Ont.

BOILER COMPOUNDS
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Dearborn Chemical Co. of Canada, Toronto.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mf.g Co., Woodstock.
Dearborn Chemical Co., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Limited, Hamilton.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal
Mason Regulator & Engineering Co., Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

BOILER GRAPHITE
Joseph Dixon Crucible Co., Jersey City, N.J.

BOILER MOUNTINGS
Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd., Montreal.
Canadian Griscom-Russell Co., Ltd., Montreal
Mason Regulator & Engineering Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg.
Laurie & Lamb, Montreal.
Wm. B. Pierce Co., Buffalo, N.Y.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
Jones Underfeed Stoker Co., Toronto.
John McDougall Caledonian Iron Works, Montreal.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
McAvity, T. & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
John McDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford, Ont.

BOOKS
MacLean Publishing Co., Toronto.

BRASS FOUNDERS
McAvity, T. & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BURNERS, ARGAND
Precision Instrument Co., Detroit, Mich.

CALORIMETERS
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CAST IRON FITTINGS
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Victoria Foundry Co., Ottawa, Ont.

CASTINGS, BRASS AND IRON
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Lunkenheimer Co., Cincinnati, O.
John McDougall Caledonian Iron Works Co., Ltd., Montreal.
McAvity, T. & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Waterous Engine Works Co., Brantford, Ont.

CHAIN DRIVES
Morse Chain Co., Ithaca, N.Y.

CHAIN WHEELS
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, STEEL
Babcock & Wilcox, Ltd., Montreal.

CHEMICALS
Dearborn Chemical Co., Chicago.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Foxboro Co., The, Foxboro, Mass.

CLUTCHES
Waterous Engine Wks., Co., Brantford.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox, Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

COMMUTATOR TRUING DEVICES
Jordan Bros., Inc., New York, N.Y.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Bellis & Morcom, Birmingham, Eng.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Wks., Montreal.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto, Ont.

CONDENSATION RECEIVER
G. M. Davis Regulator Co., Chicago.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONSULTING ENGINEERS
Walter J. Francis, Montreal.
Laurie & Lamb, Montreal.

CONTRACTORS' STRUCTURAL STEEL
Canadian Fairbanks-Morse Co., Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.

CONVEYOR MACHINERY
Babcock & Wilson, Ltd., Montreal.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Canadian Fairbanks-Morse Co., Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COOLER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUNTERSHAFTS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLINGS, BOILER, FLANGED PIPE, JOINT, PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

COUPLINGS, SHAFT
Can. Bond Hanger & Coupling Co., Alexandria, Ont.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal
Smart-Turner Machine Co., Hamilton, Ont.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Hamilton, Ont.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK AND CROSSHEAD PIN OILERS
Lunkenheimer Co., Cincinnati, O.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

CYLINDER OIL
E. H. Kellogg & Co., New York.

DAMPER REGULATORS
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Darling Bros., Ltd., Montreal, Que.
G. M. Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.

DISCS, LEATHER
Graton & Knight Mfg. Co., Montreal.

DISTILLING APPARATUS
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Sirocco Co., Windsor, Ont.

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Sturtevant Co. of Canada, Ltd., B. F., Galt, Ont.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Green Fuel Economizer Co., New York, N.Y.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
MacKinnon, Holmes & Co., Sherbrooke, Que.
John MacDougall Caledonian Iron Works, Montreal.

ELEVATING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Lindsay, Ont.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

ENGINES, HIGH SPEED, STEAM
Belliss & Morcom, Birmingham, Eng.
Can. Sirocco Co., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
John MacDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, MARINE
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works, Co., Ltd., Montreal.

ENGINES, SAW MILL
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Canadian Griscom-Russell Co., Ltd., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.
Kerr Engine Co., Walkerville.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Laurie & Lamb, Montreal.

ENGINEERING BOOKS
MacLean Publishing Co., Toronto.

EXHAUST HEADS
Can. Sirocco Co., Windsor, Ont.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Jas Morrison Brass Mfg. Co., Toronto.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Alberger Heater Co., Buffalo, N.Y.
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

FANS, VENTILATING
Can Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green Fuel Economizer Co., New York, N.Y.
Sturtevant Co. of Canada, Ltd., B. F., Galt, Ont.

FEED WATER HEATERS
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Stewart Heater Co., Buffalo, N.Y.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Stewart Heater Co., Buffalo, N.Y.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

FILTERS
Bowser & Co., Inc., S. F., Toronto, Ont.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.

FILTERS, WATER
Canadian Griscom-Russell Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Manufacturing Co., York, Pa.

FIRE BRICK, PLASTIC
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
McAvity, T. & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Toronto.
Jefferson Union Co., Lexington, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.

FLUE CLEANERS
Babcock & Wilcox, Ltd., Montreal.
Liberty Mfg. Co., Pittsburg, Pa.
William B. Pierece Co., Buffalo, N.Y.

FLUE GAS ANALYSIS INSTRUMENTS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Precision Instrument Co., Detroit, Mich.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FURNACES, BOILER
Gates, J. W., Montreal, P.Q.

FURNACES, SMOKELESS
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Economy Fuse & Mfg. Co. of Canada, Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
William R. Pierce Co., Buffalo.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GASKETS, RUBBER, ASBESTOS, LEAD COPPER AND LEATHER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.

GAS COLLECTORS
Precision Instrument Co., Detroit, Mich.

GAS PRODUCER PLANTS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
S-C Regulator Co., Fostoria, Ohio.
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Montreal.
Foxboro Company, Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity & Sons, T., St. John, N.B.
Waterous Engine Works Co., Brantford.

GRAPHITE, BOILER
Jos. Dixon Crucible Co., Jersey City.

GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Montreal.
Boiler Repair & Grate Bar Co., Toronto, Ont.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Galt Foundry Co., Galt, Ont.
Mason Regulator & Engineering Co., Moutreal.
Waterous Engine Works Co., Brantford.

GREASE CUPS
Albany Lubricating Co., New York City.
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Griscom-Russell Co., Ltd., Montreal.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal, Que.

GREASES
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jos. Dixon Crucible Co., Jersey City.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.

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BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

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Indicating Thermometers
Automatic Temperature and Pressure Regulators
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Engraved Stem Thermometers
Hydrometers
Hygrometers
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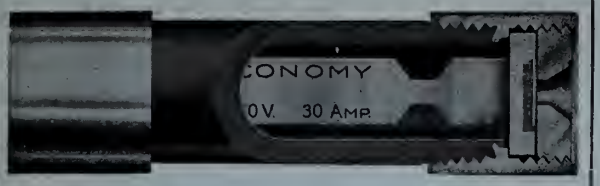

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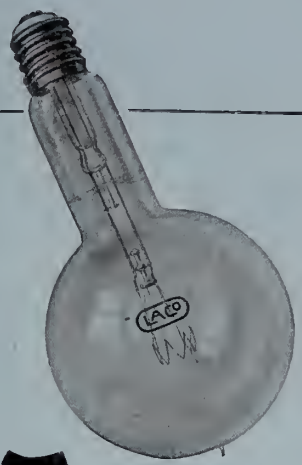

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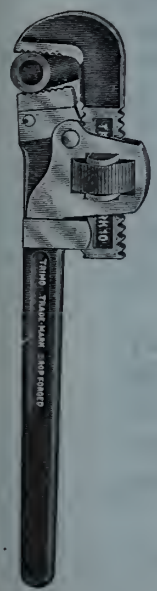

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Northcliffe

Lord Northcliffe will be a contributor to the September MACLEAN'S. The general theme of his article will be Canada's position at the present time in relation to the war and to the Empire afterwards. Be sure to read what the brilliant and dominant man has to say about our country. Get an outsider's viewpoint.

MacLean

John Bayne MacLean, publisher, editor, publicist, clear-seeing and far-seeing, has another strong article in the September MACLEAN'S. Colonel MacLean has proved himself to be as clear-sighted as Kitchener in many matters pertaining to the present war; and he is doing a needed work now in THE FINANCIAL POST and other newspapers, to arouse Canadians to a proper sense of the perils that lie ahead.

Ronald

Another smuggling revelation!

A certain Canadian town offered a big bonus to a factory. An American supplied the desired factory, smuggled into Canada the whole plant required,—and was afterwards found out and brought to book. J. D. Ronald tells the whole amazing story in the September MACLEAN'S. Mr. Ronald is contributing to MACLEAN'S a series of Canadian "inside" smuggling stories—true ones. This is great stuff.

Leacock and Laut

Stephen Leacock and Miss Agnes C. Laut are contributors as usual to the September MACLEAN'S. Leacock's humor is bubbling, sparkling and refreshing—like spring water. Miss Laut provides another of her well-informed vigorous, and revealing articles on a phase of the war in relation to Canada and the United States. Miss Laut makes us think and wonder!

Jacobs and McGrath

W. W. Jacobs contributes one of his inimitable short stories to the September MACLEAN'S. "Their Wives Went Along." Harold McGrath, world famous story-writer, who wrote "The Man on the Box," provides a complete novelette. It is a story of adventure and mystery.

Allenson and Moorhouse

A. C. Allenson contributes a short story, "A Flutter in Diamonds;" and Hopkins Moorhouse, "Their Tents like the Arabs." These two men are Canadians—winning fame, and adding lustre to Canada's record for producing short story writers of the first-class.

Hendryx

James B. Hendryx's serial, "The Gun Brand," continues in the September MACLEAN'S. A great story of the Canadian Northwest. The Movie-makers are filming Hendryx's work. So you can be sure that he's writing the right sort of stuff.

Women and Their Work

This is the title of a new department in MACLEAN'S. In the September issue, this department will contain:

Reducing my household cost.

The Care of the Child—an article by Dr. George E. Smith.

A sketch of Mrs. W. M. Davidson, a prominent Western woman, engaged with her husband in editing the Calgary Albertan.

Cooking the Cheaper Cuts,—an article on economy in the kitchen.

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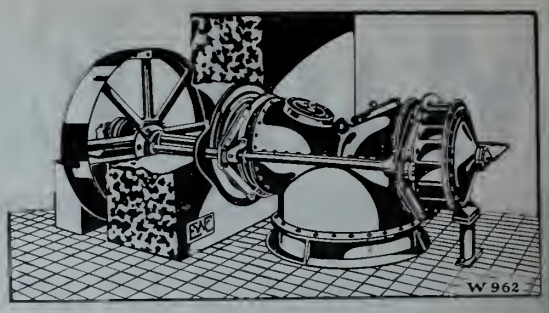

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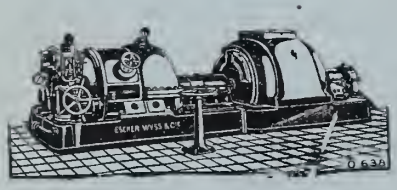

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62-17

INDEX TO ADVERTISERS

	PAGE
A	
Albany Lubricating Co.	63
Alberger Heater Co.	68
American Steam Gauge & Valve Mfg. Co.	66
American Steam Pump Co.	62
Anderson Co., V. D.	53
Armstrong Cork Insulation Co.	11
A.S.K. Chemical Co.	54
B	
Babbitt Steam Specialty Co.	75
Babcock & Wilcox	76
Bawden Machine Co., Ltd.	6
Bennis & Co., Ltd., Ed.	61
Beveridge Paper Co.	58
Boiler Inspection Dept.	79
Boving Hydraulic & Eng. Co.	74
Bowser, S. F., & Co., Inc.	63
C	
Can. Assoc. Stationary Engrs.	81
Can. Bond Hanger & Coupling Co.	72
Can. B. K. Morton Co.	5
Can. Detroit Lub. Co.	61
Can. Economic Lubricant Co.	54
Can. Fairbanks-Morse Co.	65
Can. Laco-Philips Co.	81
Can. H. W. Johns-Manville Co., Ltd.	9
Can. Morehead Mfg. Co.	8
Can. Sirocco Co.	8
Can. S K F Co.	69
Chaplin-Fulton Co.	62
Cling-Surface Co.	71
Coe Co., C. T.	6
Coppus Eng. & Equip. Co.	6
D	
Darling Bros.	8
Dart Union Co.	59
Davis Regulator Co.	60
Dearborn Chemical Co.	15
D'Este Co., Julian	14
Direct Separator Co.	71
Dixon Crucible Co., Jos.	52
Dominion Belting Co.	72
Dominion Coal Co.	74
Durabla Mfg. Co.	66
E	
Economy Fuse & Mfg. Co. of Canada	81
Escher Wyss & Co.	86
F	
Foxboro Co.	75
Francis, Walter J., & Co.	54
Frick Co.	11
G	
Galt Foundry Co.	58
Garlock Packing Co.	57
Garth Co.	74
Goldie & McCulloch Co.	18
Graton & Knight Mfg. Co.	70
Greene, Tweed & Co.	67
H	
Holmes Metallic Packing Co.	74
Homestead Valve Mfg. Co.	76
Hoyt Metal Co.	2
I	
Inglis Co., John.	Inside back cover
J	
Jamison Cold Storage Door Co.	12
Jefferson Union Co.	55
Jenckes Machine Co.	2
Jenkins Bros.	3
Jones Underfeed Stoker Co., Ltd.	83
Jordan Bros., Inc.	14
K	
Kellog & Co., E. H.	79
Kerr Engine Co.	14
L	
Ladd Co., The Geo. T.	74
Laurie & Lamb	13
Leitch Co., The Arthur S.	72
Liberty Mfg. Co.	49
Linde Canadian Refrigeration Works Co.	10
Lunkenheimer Co.	61
M	
MacGovern & Co.	84
MacKinnon, Holmes & Co.	54
Magnolia Metal Co.	56
Martell Packings Co.	66
Mason Regulator Co.	6
Mason Regulator & Eng. Co., Ltd.	7
McAvity & Sons, T.	60
McDougall Caledonian Iron Works Co.	16
McGhie, W. C.	74
McLaren, D. K., Ltd.	64
Morris Machine Works	62
Morrison Brass Mfg. Co., Jas.	Outside back cover
Morse Chain Co.	73
Murphy Iron Works	4
P	
Peacock Brothers	76
Peerless Rubber Co.	Inside front cover
Penberthy Injector Co., Ltd.	Outside front cover
Pennsylvania Flexible Metallic Tubing Co.	71
Pierce Co., Wm. B.	56
Pratt & Cady Co.	68
S	
Sarco Co., Inc.	53
"S-C" Regulator Co., The	60
Scaife, Wm. B., & Sons Co.	54
Schaeffer & Budenberg Mfg. Co.	63
Smart-Turner Mach. Co.	75
Starrett, L. S., Co.	63
Steel Mill Packing Co.	75
Storey Pump & Equipment Co.	62
Sturtevant, B. F., Co., of Canada	51
T	
Taylor Instrument Co.	79
Thomas Grate Bar Co.	75
Trimont Manufacturing Co.	83
Toch Bros.	51
U	
Uehling Instrument Co.	79
V	
Vilter Mfg. Co.	10
W	
Wall, W. J.	54
Waterous Engine Works Co.	1
Watson & McDaniel Co.	74
Williams & Co., J. H.	83
Y	
York Mfg. Co.	12

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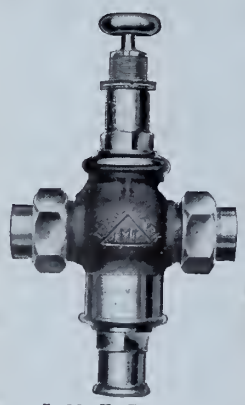
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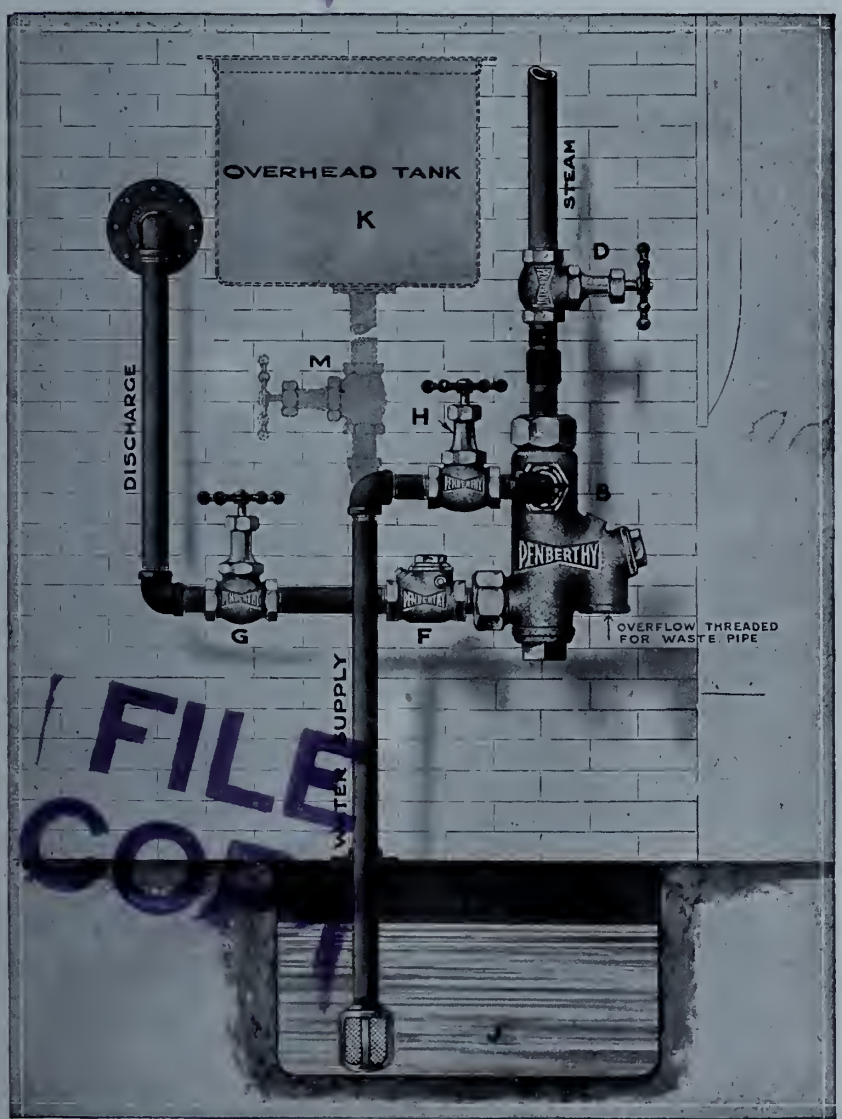

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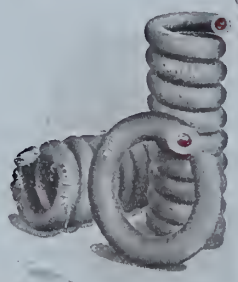

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Your Babbitt?

Hoyt Metal Co.

Eastern Ave. and Lewis St., Toronto, Can.
New York, N.Y. London, Eng.

St. Louis, Mo.

ENGINES, Pumps, Rolling Mills, Pulp Machinery or Planing Mills are given a new lease of life and increased efficiency when Frost King Babbitt Metal is applied. Where great strain is centred on the bearings, this metal proves its value.

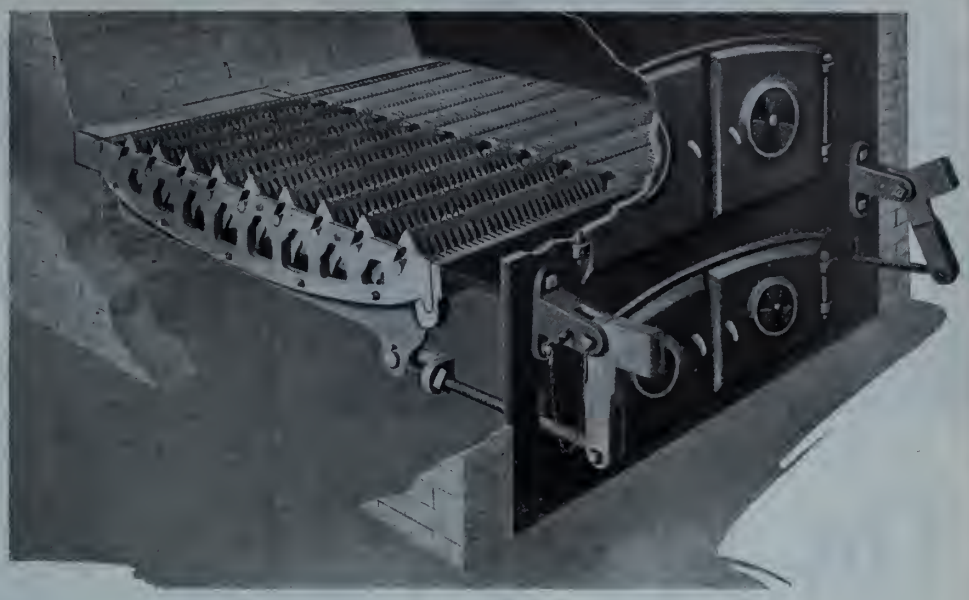
40 years of experience in making Babbitt Metal and a complete study of the uses to which it is applied have enabled us to give you a metal that is as near perfection as modern science can make it.

Our "Nickel Genuine" will do for motors, dynamos, etc., as "Frost King" will do for machinery. An inquiry will bring you immediately complete information. Ask your dealer for it, or write direct to us.

Patented

Anti-Clinker Shell Bar Grates

A Proven Success in Saving Time, Labor and Fuel



Anti-Clinker Shell Bar Grates represent a new and decidedly advanced idea in grate construction.

50 per cent. of the total surface is air space. This abundant air supply commands a perfect combustion which adds *25 per cent.* more heat to the fuel gases and prevents *clinker formation;* the fact of there being no clinkers and an abundant air supply is a guarantee of *greater heat* from *less coal.*

The grate bars as shown in cut are of the triangular pattern, hollow in the centre with *deep teeth.* The under side is open and reinforced every 2½" by cross ribs, so that nothing can remain inside, and makes it impossible to *warp* or *twist.*

Grates taken apart or put together in a few minutes. There's a lot more to tell about the efficiency of these grates. Get in touch with us.

Lessens clinker formation. Always clean. Burns slack, coal, coke or wood. By pressing lever grates are turned to new burn-surface, breaking up coal and giving a clean fire.

Grates cannot twist or warp—two grates in one.

Removes Boiler Scale and Prevents further Formation

SAVE FUEL, OIL AND PACKING

These things we absolutely guarantee you can do by using

BOICO

HERE'S WHAT BOICO WILL DO—Prevent scale from forming; gradually removes all old scale; cut the cost of fuel, oil and packing in a thoroughly practical manner.

HERE'S WHAT BOICO WILL NOT DO—It will not injure packings, valves or any metals; carry over in the steam, foam or prime.

BOICO does not contain any caustics or metallic substances of any kind likely to prove injurious to metal.

Glad to Send You a Package of BOICO on Genuine Free Trial Basis

How would you like to get in touch with users of *Boico?* They include a large number of big plants. Send for their names.

SOME OF OUR OTHER COST-CUTTING LINES

P. P. P.—Daniel's P. P. P. and Ebonite Packings for all Pressures. Only packing backed with scientific proof that it reduces friction. Long tests by Mechanical Engineers proved that P. P. P. saved 75% or more friction losses. Automatically regulates bearings on rod to requirements.

Tip-It Patent Welding Process. Scarcity and high price of high-speed steel compels rigid economy in its use. TIP-IT welding makes it possible to obtain tools with carbon shank permanently united to cutting tip of high-speed steel.

Copper Asbestos Boiler Gaskets—most successful Boiler gasket made. They never blow out and never stick. Made of corrugated copper with pure asbestos, cord filled corrugations. Use them and end all leaks in pipe lines.

Write for full particulars

Shell Bar, Boico Supply, Limited

376 DUFFERIN STREET - - TORONTO, CANADA

DOMINION SUGAR CO., Ltd., KITCHENER, ONT.

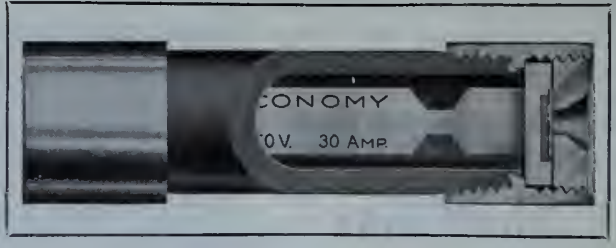
The Evidence

This battery of "Jones Stokers" saved over half its cost in a trifle over two months.

This kind of evidence is such that will convince the most critical and skeptical. The savings Jones Stokers have effected in other plants can be accomplished in yours. Think it over.

In many plants a great amount of coal goes up the chimney in smoke. With the "Jones" installed absolutely no smoke is caused. The chimneys are known as "smokeless." The name is well earned. Cheaper grades of coal may be used. The stokers regulate the amount of coal fed in accordance with the demands for steam. Every particle of coal is used, to give its maximum value. You should be one to benefit. We will gladly furnish information.

Jones Underfeed Stoker
Company, Limited
37-41 Britain St. - TORONTO



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Light and Power Companies
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Office Buildings
Department Stores
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United States Navy
Every other company who have trouble with their fuses.

Economy fuses effect a saving of 80% in yearly fuse maintenance. Economy Cartridge fuses are renewable. Made in Canada and sanctioned by the Canadian Fire Underwriters' Association. Free Samples of any type supplied with our catalogue No. 24.

Economy Fuse & Mfg. Co. of Canada Limited
Unity Building Montreal

Manufacturers in Canada of "S & C" High Potential Fuses, to150,000 volts.

MAN POWER

must not be wasted in tasks which can be better done by machinery. The handling of coal and ashes, for instance, is work for a machine not for a man, and the most efficient machinery for the purpose is a "Bennis" equipment. We are the largest makers in the Kingdom of this class of machinery, and shall be pleased to send you all information regarding our Automatic Stokers, Coal Elevators and Conveyors, Ash Removal Plant, etc., installed in works similar to your own, with large savings not only in labour but also in coal, boilers and money.

Write for catalogues.

ED. BENNIS & CO., Limited
Little Hulton, Bolton, and
28 Victoria St., LONDON, S.W., England

GALT SPRINKLER STOKERS

are reliable, inexpensive and efficient

BOILER CAPACITY COMBINED WITH SMOKELESS COMBUSTION

A post card will bring catalogs and full information

Galt Foundry Company, Galt, Ont.

Toronto Representative: W. M. McROBERT, 92 SYMINGTON AVE. Phone: Junction 3354

Murphy AUTOMATIC Furnace

BOILER TESTS

A series of tests (11) were run with a 685 *H.P.* STERLING boiler and MURPHY stoker—*after being in use more than seven years; natural draft;* "Under actual operating conditions": Westmoreland slack coal.

TEST NO. 4, *at* 149.4% *rating;* efficiency of boiler and stoker 71.8%. *TEST NO.* 8, *at* 182.5% *rating, combined efficiency* 80.4%. *TEST NO.* 10, *at* 226% *rating,* forced draft, 4 hours (maximum rating 277.5%); *net efficiency* 72.2%.

The *average combined efficiency* of the 11 tests (72 hours) was 76.2% at 172% average capacity rate. *No other* stoker can beat it! *Less than* 1% *of steam was used for actuation!*

For full test data write, to-day, to

MURPHY IRON WORKS, BUFFALO, N.Y., or DETROIT, MICH.

THOMAS ELLIPTIC GRATE BARS— SHAKING CIRCLE STATIONARY

Increase steam—Save fuel—Save labor—Cost less—Reduce smoke.

Shipped from Hamilton, Ont. **Let us give you complete information**

FOR ALL PROBLEMS—**Steam—Grate Bar—Furnace—write THOMAS**

THOMAS GRATE BAR CO., Birmingham, Ala., U.S.A.

WHY put in another boiler

WHEN you can increase your present steaming capacity to 200 and in connection with stokers even 300% of the normal rating of the boilers without injury to the boilers by installing a

COPPUS TURBO BLOWER

You will have all the steam you want all the time. Hundreds of satisfied customers will attest to this. No drop in steam pressure when a heavy load comes on, and you can laugh at the weather man, as you can dispense with him for your draft. Besides, the blower will pay for itself in a short time, as it will burn cheaper fuel.

Cut out this Ad., put your name and address on the margin, and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

In boilers equipped with Coppus Turbo Blowers in four years. The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company

167 Union Street, Worcester, Mass.
Montreal Sales Agents
H. L. Peiler & Co., Montreal and Toronto,
Toronto Sales Agents:
The Power Plant Equipment Co., Toronto, Ont.

BAWDEN NEVER SHORT STROKE PUMPS

BAWDEN

General Service Pump

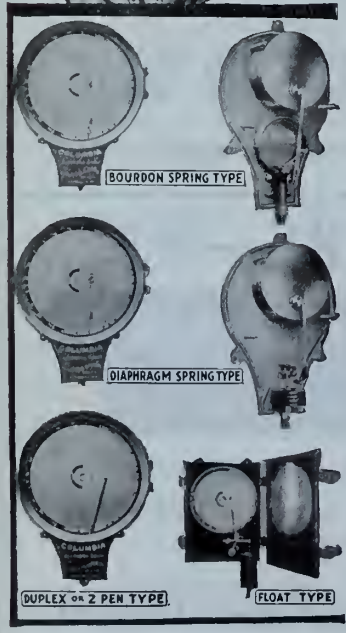
NO Tappets. NO External Valve Gear Levers or Springs. NO Internal Tubes or Stuffing Glands.
Construction is of very best throughout.
The Steam Cylinders are designed to withstand modern pressures. They are fitted with cast iron block pistons, self-adjusting cast iron rings and steel rods. Water cylinders are of suitable strength for pressures not exceeding 100 lbs. per square inch.

Drop a card for full particulars.

The Bawden Machine Co., Ltd.

133 Sterling Rd., Toronto, Canada
Agents for Quebec Province:
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
380 St. James Street, Montreal, P.Q.

"COLUMBIA" RECORDING GAUGES



This, gentlemen, is the "Columbia" chart. We make it as distinctive in appearance as possible, because it is your guarantee for absolutely accurate records of Pressure, Vacuum and Draft. That's why we designed the original "day and night" border.

Our line of "Columbia" Recording Gauges covers every modern industrial requirement from the measurement of very low draft to the measurement of the highest hydraulic pressures.

And our "Columbia" Recorder is designed and built with a thorough understanding of industrial requirements. Accurate always, sensitive, sturdy and equipped with innumerable features that are positively exclusive.

Get our Catalog Section P.H. 100.

P.S.—I'll be with you next month.

Schaeffer & Budenberg
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ALSO Gauges for all Pressures, Vacuum and Draft; Thermometers, Tachometers, Counters, Calorimeters, etc.

MASON

Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

Mason Regulator Company
BOSTON, MASS.

IN CANADA
The Mason Regulator & Engineering Co., Ltd.,
Successors to H. L. Peiler & Co.,
Montreal and Toronto.

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

If Quality of Manufacture and Reliability in Service

have any meaning in the Engineering World, this list of our leading specialties should appeal to the best judgment of every Engineer and Power Plant Superintendent.

Mason Standard Bronze Reducing Valve

Mason Reducing Valves (Genuine),
Mason Pump Governors,
Mason Pressure Controllers.

Bundy Steam Traps for every service,
Coppus Turbine-driven Blowers,
Sims Hot Water Generators.

Sims Storage Heaters,
Sims Open Feed Water Heaters.

Bundy Oil Separators,
Ashton Gauges and Safety Valves.

Federal Metallic Packing,
Everlasting Blow-off Valves.

Bawden Pumps (Reciprocating & Centrifugal)
Stratton Steam Separators.

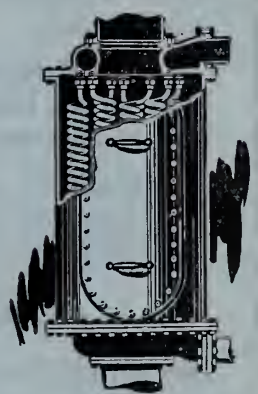
Reilly Multicoil Feed Water Heaters,
Reilly Evaporators and Distillers,
Reilly Multiscreen Feed Water Filters.

New Bundy Return Trap

Mason No. 55 Pump Pressure Regulator

ABOVE EVERYTHING

our Sales Engineers know the *practical application* of our lines to *actual conditions,* and sell from *knowledge,* not from *catalogs.* We furnish *results,* not merely *machinery.*



Reilly Multicoil Feed Water Heater

THIS MEANS REAL SERVICE

Bulletins and full information gladly furnished.

The Mason Regulator & Engineering Co., Limited

Successors to H. L. PEILIER & COMPANY

MONTREAL, 380 St. James Street — TORONTO, 311 Kent Building

FACTORY, 960 St. Paul Street, Montreal

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ECONOMY UNIFORMITY

AMACOL ATLAS
TENAXAS MASCOT
TIN TOUGHENED W. E. W. BABBITT

HAVE A WORLD-WIDE REPUTATION FOR UNIFORMITY

ATLAS Alloys are scientific products—the result of much patient research and long years of experience. They are manufactured under the most modern scientific conditions, thereby eliminating any element of chance in their composition and ensuring a standard maintenance of quality and uniformity.

ATLAS Brands are not alloys that *sometimes* give *satisfaction.* They are alloys that can be implicitly relied upon *always.* They are alloys with our *prestige* and *reputation* always behind them.

DO not let prejudice stand between *you* and *profit.* You can obtain the *maximum efficiency* from your plant at a *minimum of cost* by using ATLAS BABBITTS.

THERE IS AN ATLAS BRAND TO MEET ANY NEED

NO SHOCK TOO SEVERE NO WEIGHT TOO HEAVY NO SPEED TOO GREAT

Atlas Metal and Alloys Company of Canada, Limited
MONTREAL

Sales Agents:

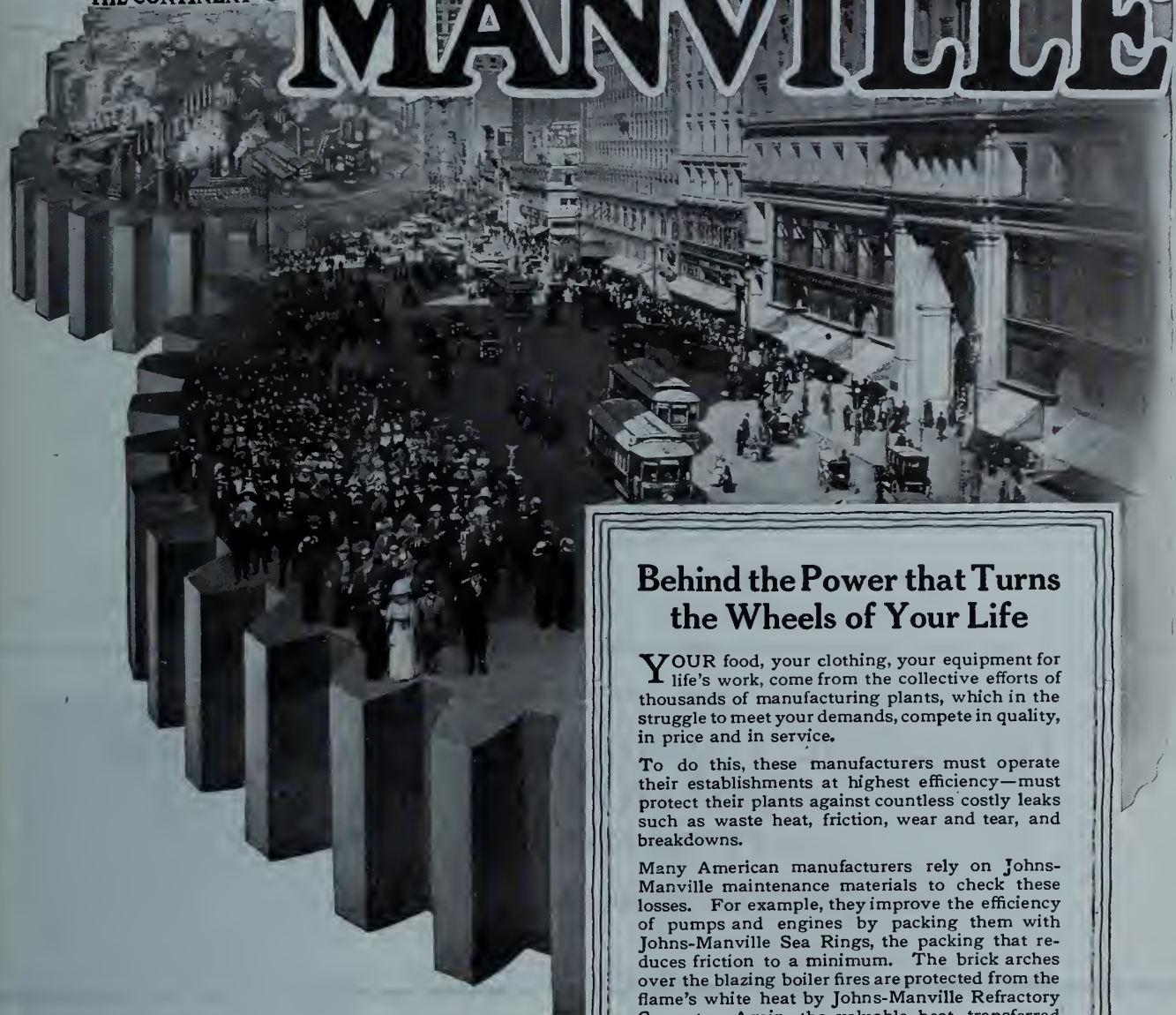
The Canadian B. K. Morton Co., Limited

MONTREAL
49 Common Street
Phone M. 3206

TORONTO
86 Richmond Street East
Phones M. 1472-1473

JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

JOHNS-MANVILLE



Behind the Power that Turns the Wheels of Your Life

YOUR food, your clothing, your equipment for life's work, come from the collective efforts of thousands of manufacturing plants, which in the struggle to meet your demands, compete in quality, in price and in service.

To do this, these manufacturers must operate their establishments at highest efficiency—must protect their plants against countless costly leaks such as waste heat, friction, wear and tear, and breakdowns.

Many American manufacturers rely on Johns-Manville maintenance materials to check these losses. For example, they improve the efficiency of pumps and engines by packing them with Johns-Manville Sea Rings, the packing that reduces friction to a minimum. The brick arches over the blazing boiler fires are protected from the flame's white heat by Johns-Manville Refractory Cements. Again, the valuable heat transferred through pipes, ducts and flues is conserved by Insulations made from Johns-Manville Asbestos and Magnesia. And in hundreds of other instances, Johns-Manville materials are employed to reach you with a better product at the lowest cost.

So that of all the ways—some direct, some devious—by which Johns-Manville serves the public, none is more important than this function of maintenance, this power economy at the very heart-center of industry.

The Canadian H. W. Johns-Manville Company, Limited

Montreal Toronto Vancouver Winnipeg

A Johns-Manville Sea Ring

JOHNS-MANVILLE POWER PLANT MATERIALS

A variety of specially developed insulations, including: Asbesto-Sponge Felted Insulation, 85% Magnesia Insulation, Asbestocel Insulation.

Packing and other Power Plant specialties, such as:

Underground Insulation System for Pipes
The Johns-Manville Fire Extinguisher
The Johns-Manville Steam Trap
Asbesto-Metallic Brake Blocks
High Temperature Cements
The Johns-Manville Sea Ring
Universal Piston Packing
Mogul Valve Stem Packing
Kearsarge Boiler Gaskets
Service Sheet Packing
Seigelite Sheet Packing
Duplex Packing

FOOD CONSERVATION

NATIONAL MOVEMENTS ARE BEING INAUGURATED
TO PREVENT ALL KINDS OF WASTE
YOU CAN ASSIST

in these movements and Increase Your Profits by Installing a "LINDE" System in place of Unsanitary Methods.

LINDE SYSTEMS ELIMINATE WASTE

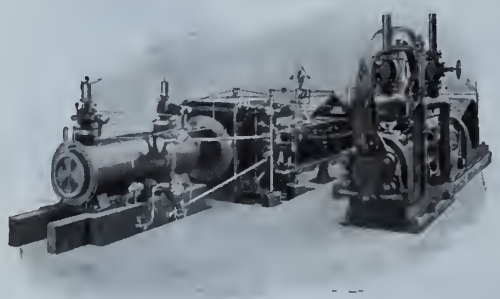
If the Linde Machine costs a little more to buy, it costs a good deal less to own; and that is true economy. It runs the longest and for the least money.

THE LINDE CANADIAN REFRIGERATION COMPANY, LIMITED

37 ST. PETER STREET, MONTREAL

Manufacturers of Quality Refrigerating Machinery

Vilter Refrigerating and Ice Making Equipment



is recognized as standard throughout the world. Our product is built in all sizes and capacities, suitable for every service to which refrigeration is applied. Write us for an estimate covering your requirements.

POPPET VALVE and CORLISS ENGINES.
Ammonia Fittings, Condensers, Brine Coolers, etc.

Bulletins sent upon request.

THE VILTER MANUFACTURING CO.

242 Beecher St. Milwaukee, Wis.

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

Quality is Paramount

Frick Equipment holds its enviable position in the refrigerating field, due to the quality of material and workmanship.

Many repeat orders are being booked through the wonderful performance of former machines.

The above cut illustrates a third order for a 300-Ton Machine received from a large packing house.

Get our latest catalogue and list of users.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives:
FRICK ICE & REFRIGERATING COMPANY
Montreal, Canada

How Much Refrigeration Are You Losing?

Do you know how much you can save by having your cold pipes covered properly? The season for making repairs and putting your plant in first-class shape is at hand. Wouldn't it be a good plan to get as much information as possible and look into the merits of

Nonpareil Cork Covering
For All Cold Pipes

before it is too late?

This 64-page book covers the subject of cold pipe insulation pretty thoroughly. It does not make broad, general statements, but gives you real information that will enable you to figure out for yourself just how much refrigeration you are losing through your bare, cold pipes. In fact, it is not a book that you will glance through and then throw away, but one that you will keep for reference purposes.

The book is free. Just mail the coupon to-day.

ARMSTRONG CORK & INSULATION CO.
504 McGill Bldg., Montreal, Que.

Also manufacturers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings; Circle-A Cork Brick for cold storage and ante-room floors; Nonpareil Cork Machinery Isolation for sound deadening; and Linotile floors for offices, residences, etc.

Armstrong Cork & Insulation Co., Ltd.,
504 McGill Building, Montreal, Que.

Gentlemen:

Please send your free book, "Nonpareil Cork Covering for Cold Pipes."

Name .....

Address .....

Town .....

Requested by.....

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Something New

In the 4th Edition of our Fittings Catalog, recently issued, we illustrate a line of SCREW AND FLANGED AMMONIA FITTINGS, supplementing the large line of Standard YORK Valves and Fittings which are coming into more general use each year.

This is in line with our policy to design and place on the market Fittings and Apparatus that will make the application of MECHANICAL REFRIGERATION more convenient and economical.

From the number of orders received, it is quite evident that these SCREW AND FLANGED FITTINGS have met with the endorsement of the practical Engineer.

By their use YOU can—

SAVE WEIGHT WITHOUT LOSS OF STRENGTH OR CONVENIENCE.

ELIMINATE *ONE-HALF* THE *GASKET* JOINTS.

DO MORE RAPID PIPE FITTING, by ELIMINATING *ONE-FOURTH* OF *ALL JOINTS.*

as compared with full flanged fittings.

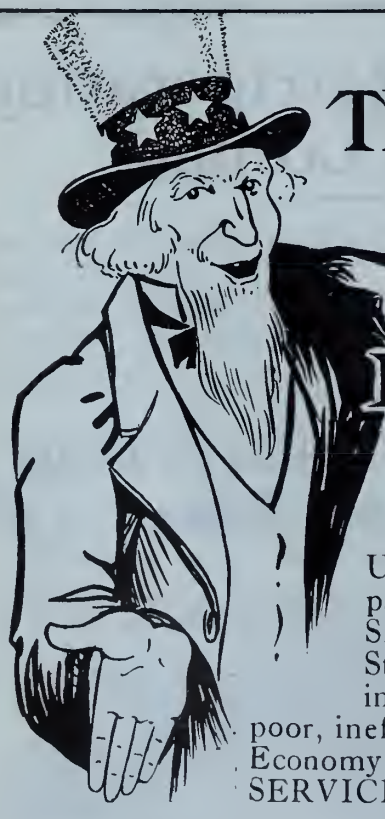
York Manufacturing Co.

(Ice Making and Refrigerating Machinery Exc'usively)

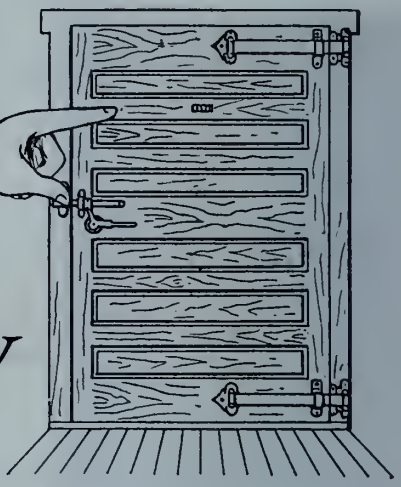
YORK, PA.

Represented in the Dominion by **CANADIAN ICE MACHINE COMPANY**

MONTREAL, 626 Coristine Bldg. TORONTO, 82 Chestnut St. WINNIPEG, 85 Lombard St



These Doors SERVE Because They SAVE



UNCLE SAM uses them. CANADA uses them. The biggest packers and storage houses use them. BECAUSE THEY SAVE DOLLARS. "JONES" AND "NOEQUAL" Cold Storage and Freezer Doors (standard or fireproof) are rendering a National service because they shut out losses caused by poor, inefficient doors. May we have the pleasure of sending "The Economy of Patented Cold Storage Doors" which describes the SERVICE fully?

Jamison Cold Storage Door Co.

Formerly Jones Cold Storage Door Co. HAGERSTOWN, MD., U.S.A.

There is but ONE Effective Method of preventing or correcting Feed Water Troubles—
Scale, Corrosion, Pitting, Bagging and Foaming
it is
Dearborn Treatment

WE are and have been for 25 years primarily interested in the scientific investigation of water, as related to steam boiler economy; determining, by careful analysis of boiler feed supplies, what properties there are in such waters that eat their way into boiler plates, form scale, produce leaks, corrode the iron, and cause many other evils well known to steam users; and preparing reagents, combined scientifically to meet individual water conditions that will successfully combat these elements.

Our laboratories make complete mineral analyses free of charge for plants interested in obtaining relief from their boiler water troubles.

After the analysis is completed we furnish reports of our results, and advise definitely regarding treatment required, cost per thousand gallons of water, method of applying treatment, etc.

Let us advise what we can do for you. Send a gallon sample of your feed water to-day.

Dearborn Chemical Company of Canada, Limited

1220-30 Dundas Street, Toronto, Ontario, Canada

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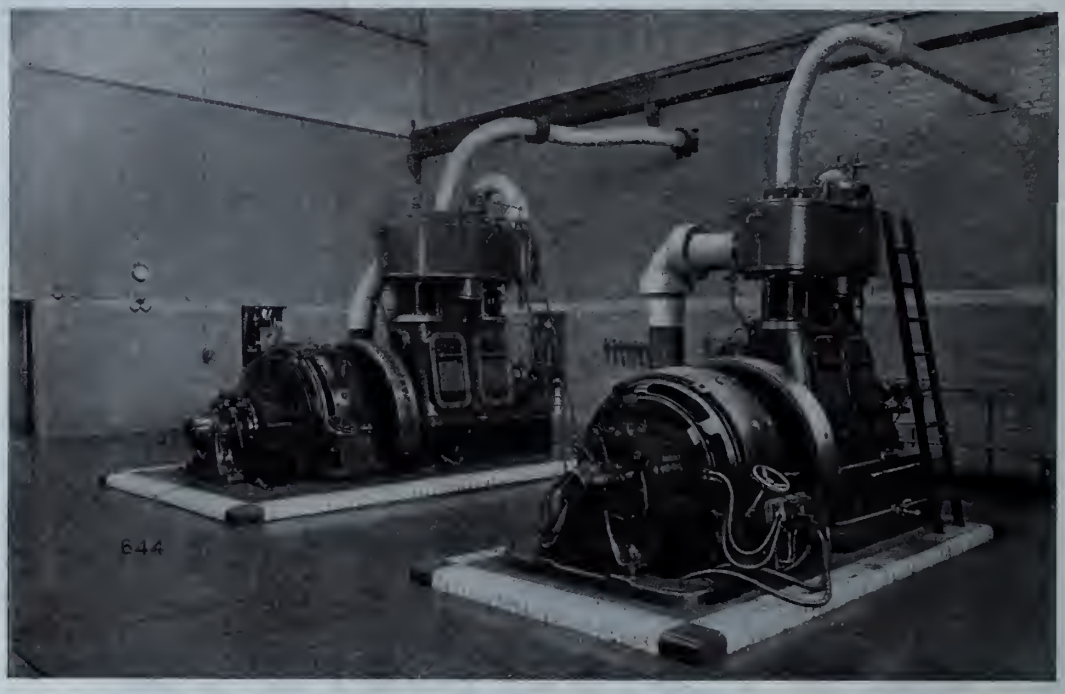
BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: **MONTREAL**

JENKINS BROS.'

TYPE "K"

Brass and Iron Body GATE VALVES

"Perfect Valves for Perfect Service"

Fig. 300

TYPE "K" GATE VALVES have so clearly demonstrated their worth under the most exacting conditions that wise-buyers never order others.

Stocks at all Dealers.

CATALOGUE No. 8 FREE ON REQUEST.

TRADE JENKINS MARK Jenkins Bros

Jenkins Bros. LIMITED

TRADE JENKINS MARK Jenkins Bros

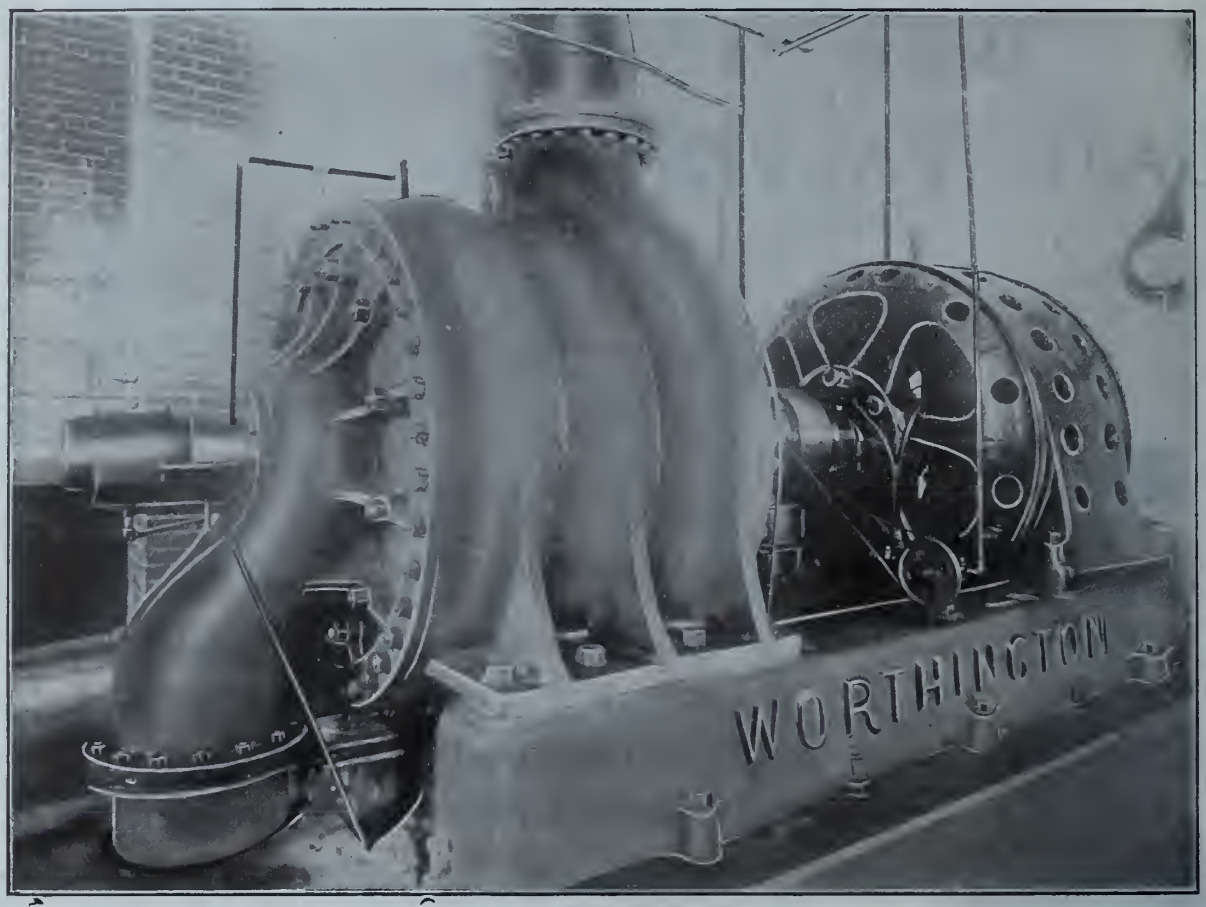
103 ST. REMI ST. MONTREAL

If any advertisement interests you, tear it out now and place with letters to be answered.

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works: Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps.

The Publisher's Page

TORONTO September 20, 1917

Pass It Along

A SHORT time ago the writer called on an engineer in charge of a very large plant and was shown through the engine and boiler rooms.

In the course of our conversation the engineer described how he had overcome certain problems. The troubles he had encountered were typical of the problems other men are running up against constantly and his method of overcoming them would interest scores of brother engineers.

"Why did you not write POWER HOUSE telling our readers about this?" I asked my friend the engineer.

"Well to tell the truth," he replied, "I have thought of it but have never got round to it. I never seem to have time."

Now, friends, this engineer had an assistant and admitted that he had a certain amount of spare time—enough indeed to spare for writing POWER HOUSE describing the "kinks" referred to. The trouble was he hadn't tried as hard to overcome the problem of finding time to write as he had tried to solve his engineering troubles!

An idea printed in POWER HOUSE multiplies in usefulness many hundred fold. It doesn't take long to pencil a few lines and make a rough sketch and yet this is all our editor requires to properly present your idea.

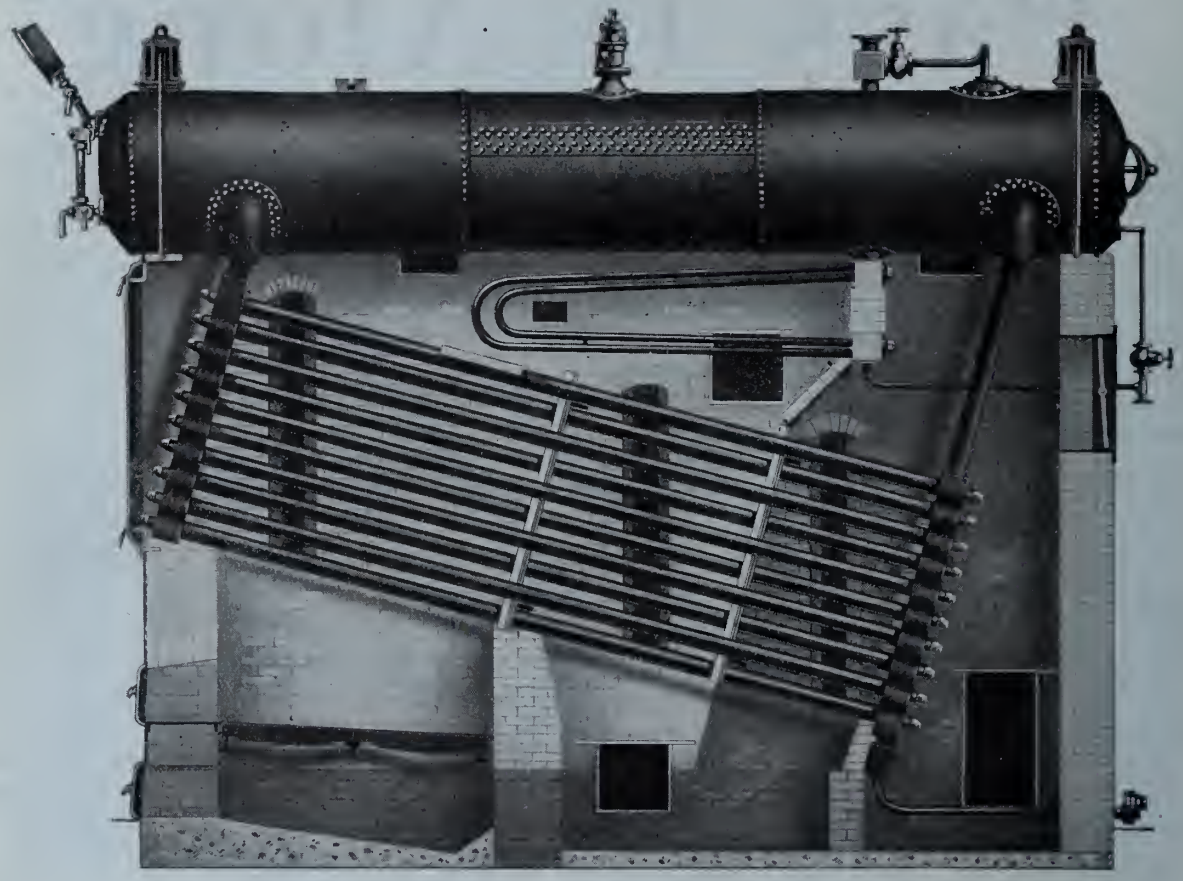
Scores of engineers may be able to make use of that pet scheme of yours. Why not simply **make** time and send us particulars? It would really be a generous act on your part and if it came right down to the fine thing it might be considered just a little selfish if you didn't do that much to help your brother engineer. (We will gladly pay you for any contribution you may send us).

And don't think it entirely necessary to contribute an idea when you write us. If you have a problem and find yourself stumped tell our engineer-readers. Some fellow may be able to help you right off the bat, having discovered the solution to your problem through experience dearly bought at some time or other. It may never occur to him, however, that someone else might be stuck just as he was.

POWER HOUSE is yours for service and for greater service. It is out to help you and no expense will be considered too great and no trouble will be spared to help you. But the greatest help to the greatest number will be given when **YOU** feel moved to throw off that little bit of indifference and pass along your ideas. It will do you no good to keep them hidden in your own plant. It **will** benefit hundreds of others if you pass the good word along. And that's what makes life worth living. It's what enables some people to live such full and such happy and useful lives.

G. & McC. CO.

BOILERS



Sectional View, Standard Type "B," Sectional Water Tube Boiler, with Superheater.

G. & McC. Water Tube Boilers are fitted with large Steam and Water Drums, connecting nipples of increased size and straight 4" tubes, all of which insure

POSITIVE AND RAPID CIRCULATION, and INCREASED STEAMING CAPACITY

All parts subjected to steam pressure are made of FORGED STEEL

G. & McC. Engines and Boilers are giving satisfaction in thousands of Canada's leading industrial institutions. Write us for prices, plans, specifications, etc.

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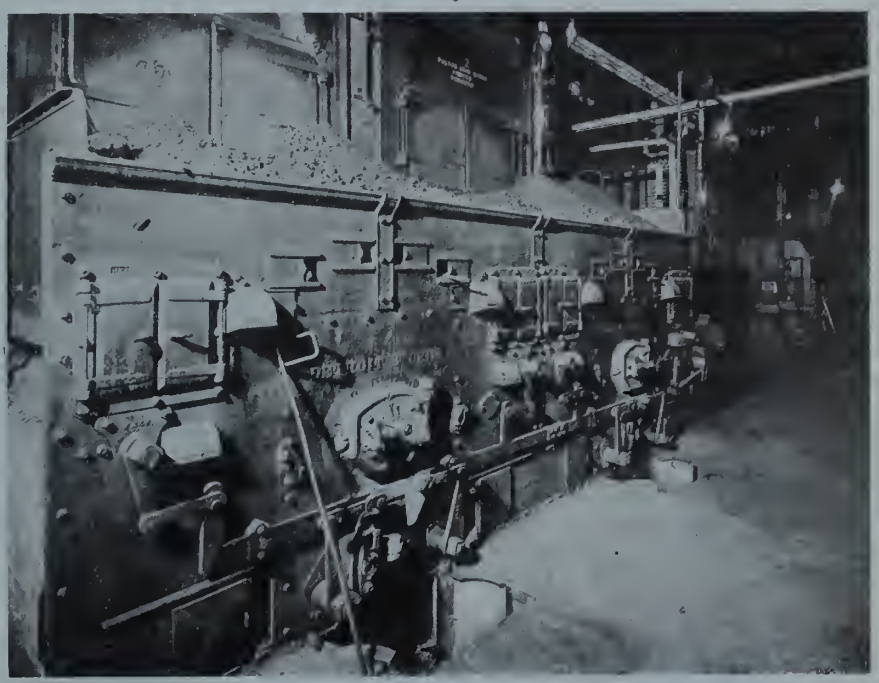
QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

Power Equipment Installation for Candy Manufacture

Staff Article

To secure a big scale output of candy and chocolate products demands as a manufacturing auxiliary a modernly equipped steam-electrical power plant. To those of us located in the cities of this Dominion, it is readily apparent that the consumption of candies — wise or otherwise, has assumed enormous proportions. To meet the situation, an industry of considerable scope has been developed, and in the matter of individual plants, that treated in the accompanying article may be taken as a typical example of the many existent.

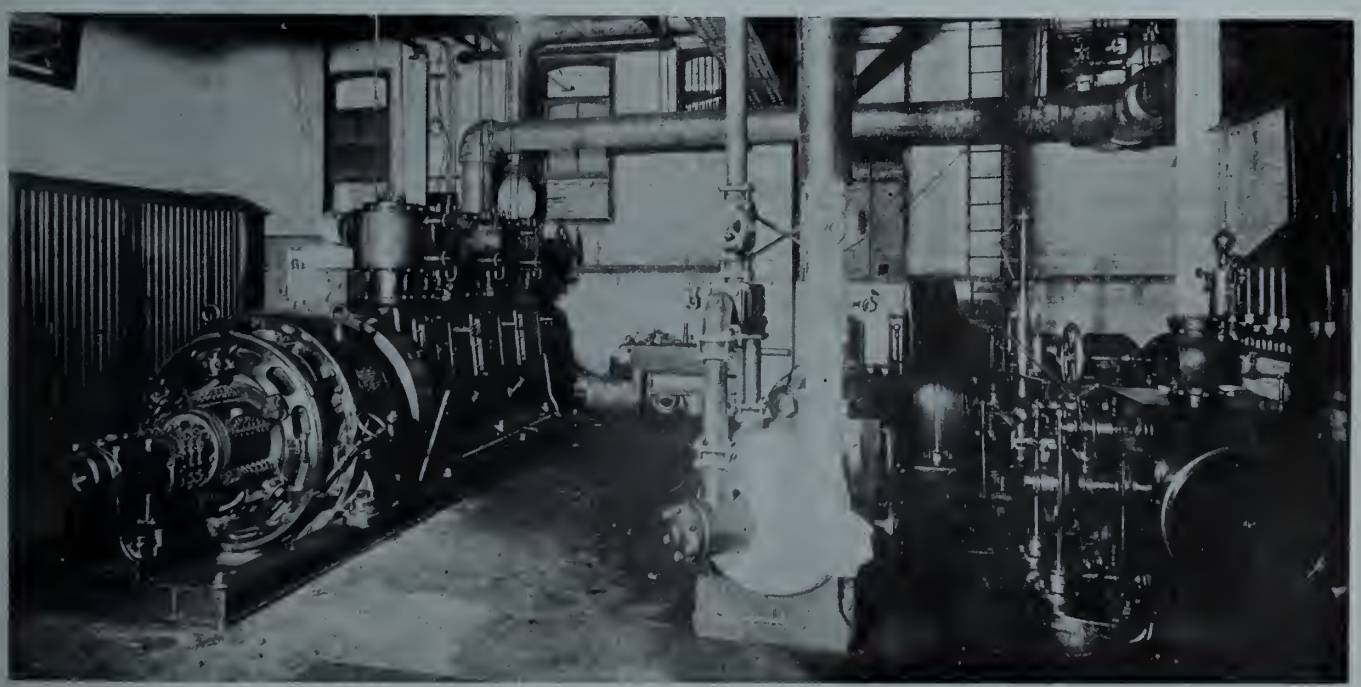
THE old established firm of Robertson Bros., Ltd., Queen Street East, Toronto, is one of the leading concerns in Canada manufacturing candy and chocolate products. The business has in recent years increased considerably in volume and consequently more power was required for operating the factory. Although the power plant is not entirely of recent date, new equipment installed during the past year has brought it more or less up-to-date besides increasing the power available by 450 h.p. and providing a fair reserve for future requirements. The new power units consist of 300 h.p. and a 150 h.p. Ashworth-Parker high speed engines, also two 125 h.p. return tubular boilers. At the time the capacity of the power plant was increased the boiler room was rearranged, the three existing boilers being replaced by new ones and Detroit stokers installed throughout.



BOILER ROOM SHOWING "DETROIT" STOKER INSTALLATION.

Boiler Room

The boiler installation consists of five return tubular boilers arranged in two batteries of three and two respectively, all having been installed recently. The three boiler battery units are each 66 in., diameter by 14 feet long and are rated at 100 h.p. while the two boiler battery units are each 72 in., diameter by 16 feet long and are rated at 125 h.p. each. The 100 horse power boilers were built by the International Engineering Works, Amherst, N.S., and those of 125 horse power by the Polson Iron Works, Toronto. The working pressure is 115 lbs. per sqare inch, which is reduced to 90 lbs., for the boiling pans, etc., in the factory. The boilers are all equipped with Dutch oven furnaces and Detroit mechanical stokers, the latter being arranged in two distinct units as



SHOWING "ASHWORTH-PARKER" 250 K.W. ENGINE WITH L. D. & M. CO. GENERATOR, AND 65-TON "YORK" STEAM-DRIVEN AMMONIA COMPRESSOR.

the two batteries of boilers are separated from one another.

Pumps

The pumping installation is located midway in the boiler room between the two batteries of boilers and comprises the vacuum and boiler feed pumps. There are three boiler feed pumps which include the following:—One Worthington, duplex, horizontal, pot valve pump, 9—5—10 ins.; one Northey 6—3½—7 in. horizontal, outside packed, plunger pump, and a tandem duplex pump by the Canadian Steam Pump & Machine Co. The returns from the low pressure heating system are taken care of by two 8—14—12 ins. vacuum pumps supplied by Deane Bros., Holyoke, Mass.; there is also a Martin vacuum pump as a reserve unit. The heating system is supplied with exhaust steam from the engines, the returns being pumped to a 700 h.p. Otis feed water heater located in the boiler room. The condensation from the boiling kettles and other steam equipment in the factory is returned to the boilers under pressure by means of No. 3 Morehead and No. 7 Cole return traps, located on top of the boilers.

SHOWING 150 K.W. "ROBB" HORIZONTAL ENGINE WITH C.G.E. GENERATOR, AND "ASHWORTH-PARKER" 100 K.W. VERTICAL UNIT WITH L. D. & M. CO. GENERATOR.

Engine Room

The company generates all its own power for the factory motors and lighting system, which is direct current throughout. There are three steam-driven generating sets giving a total of 675 h.p. exclusive of the steam driven ammonia compressor. The three steam engine units consist of the two Ashworth-Parker high speed engines installed recently and a Robb-Armstrong high speed engine installed at an earlier date. The Robb engine is an enclosed horizontal 150 k.w. unit, 17 x 16 inch cylinder, direct connected to a Canadian General Electric direct current generator of 120—240 volts, 600 amperes, and running at 225 r.p.m. The other two units were built by Ashworth & Parker, Bury, England, and were supplied through the G. H. Tod Co., Toronto. The larger engine is a non-compound, vertical, enclosed high speed unit of 250 k.w. and has three high pressure cylinders each 16 in. diameter by 8 in. stroke. Its rating is 300 h.p. when running at 450 r.p.m. This engine is direct connected on the same sub-base to a 225 volt, 900 ampere, direct current generator built by the Lancashire Dynamo & Motor Co.

The smaller unit is 100 k.w., of the same type, but having two cylinders each 14 ins. diameter by 7 ins. stroke. It is direct connected to a 100 k.w. 3 wire, compound wound, 250 volt, 400 ampere, direct current generator running at 500 r.p.m. This generator was also built by the Lancashire Dynamo & Motor Co. Both engines are equipped with Charlton Whitehead governors ensuring a maximum variation of 2 per cent., no load to full load. Each generator is compound wound and fitted with interpoles to give sparkless commutation at all loads, also 3 wire equipment consisting of slip rings and static transformers capable of dealing with an out-of-balance current of 20 per cent. The full load efficiency of the 250 k.w. generator is 92 per cent. and of the 100 k.w. generator 91 per cent.

Switchboard

The switchboard has five panels of grey marble and is 6 ft. by 11 ft. It was supplied and equipped by the Canadian General Electric Co., Toronto. The first panel controls the Robb engine generator and has a circuit breaker, 600 ampere double throw switches, and two ammeters. The second panel is for the 100 k.w. steam driven unit and has a circuit breaker, 400 ampere switches and also two ammeters. The third panel controls the 225 k.w. generator, and has a circuit breaker, 900 ampere switches and two ammeters. The fourth and fifth are distributing panels and have a number of switches controlling the different sections of the factory. At the left hand side of the board are two volt meters on a swinging bracket. There are approximately 40 motors in the factory ranging from ¼ to 40 h.p. The lighting system is 3 wire, 120 volts, d.c.

There are several chocolate cooling rooms in the factory and in connection with these is a refrigerating unit installed in the engine room. This unit is a 65 ton York horizontal, steam driven, ammonia compressor operating on the direct expansion system. The steam engine, which is of Corliss type, has a cylinder 20 in. in diameter by 20 in. stroke and the ammonia compressor has a 14 inch cylinder by 24 in. stroke.

GASKET MEMORANDA

A THIN gasket is best where joint surfaces are smooth, and is less likely to blow out than a thick one.

Gasket seats should be well cleaned and pieces of old gasket removed before placing the new gasket in position.

When installing a gasket, the object should be to apply, when setting up on it, an even, well-distributed pressure over as large a part of the surface of the gasket as possible. Nuts should not be set up too tightly in the beginning, but should be followed up as found necessary to prevent leaks when the steam pressure rises.

Cases have been experienced where handhole plates were set up so tightly with a long-handled wrench that the new gasket was mostly squeezed out of the joint and its structure torn in places. These small crevices or torn places form small openings, through which steam soon leaks, and the only remedy is to replace the gasket which has been ruined.

Gaskets with too wide a flange surface, or carelessly put in place, may project too far beyond the edge of the joint and jam the handhole or manhole cover at that point, so it cannot be set up or made to seat propertly.

Gaskets of compressed fiber sheet are likely to tear when the joint is broken and to leave pieces of the old gasket sticking to the metal. These often form high spots which are easily overlooked, and likely to cause leaks and the condemnation of new gaskets which are not faulty.

ROPE CAPACITY OF A DRUM

A CONVENIENT rule for computing the rope capacity of any sized drum is as follows:—Add the depth of flange in inches to the diameter of the drum, and multiply this result by the width (out to out) of the drum. This product is then multiplied by the figure below corresponding to the size of rope used:—

¼	in.	4.16	1⅜	in.	.138
⅜	in.	1.86	1½	in.	.116
7-16	in.	1.37	1⅝	in.	.099
½	in.	1.05	1¾	in.	.085
9-16	in.	.828	1⅞	in.	.074
⅝	in.	.672	2	in.	.066
¾	in.	.465	2⅛	in.	.058
⅞	in.	.342	2¼	in.	.052
1	in.	.262	2⅜	in.	.046
1⅛	in.	.207	2½	in.	.042
1¼	in.	.167			

Engineering Exhibits at the Canadian National Exhibition

Staff Article

The value of Canada's premier Annual Fair as an occasion on which to gain publicity is again justified by a visit to the Machinery Hall, while any doubts regarding the mechanification of the farmer are instantly dispelled by an examination of tractors, electric light plants, and other aids toward a labor-saving and luxurious existence for sons of the soil.

DESPITE the absence of a few notable exhibitors of former years, the engineering features of the exhibition, both in the Machinery Hall and elsewhere, have aroused probably a more wide-spread interest than for many years past. The fact that many people, brought in contact with engineering practice through the temporary activity of munitions production, are now earnestly endeavoring to find a permanent outlet for their efforts is one, if not the main reason for the great general interest displayed by visitors this year.

PART OF PRATT & WHITNEY'S EXHIBIT OF SMALL TOOLS.

Present conditions, of course, have postponed any improvement in the facilities afforded exhibitors, but had proper and deserved encouragement been given in a timely manner, the machinery display would not be handicapped by comparison with certain annual events in the States, which are noted for the facilities offered exhibitors in such important matters as steam, gas, air and electricity supply, especially in the matter of reasonable charges for the latter service. As matters are now, it is only through the loyalty and patriotism of exhibitors, who annually face the expense and inconvenience of two weeks' dislocation of regular business, that the standard of the show has been maintained at its present level. In view of the services rendered to the Empire, and the great degree of confidence with which the industry is regarded as a mainstay of the country in the future, no excuse short of absolute lack of funds can justify a continuance of the present lukewarm attitude of the authorities toward engineering exhibitors. The thanks of the industry are indeed due to those who continue to "carry on."

The general state of affairs is indicated by one noticeable change in the aspect of the show—munitions have disappeared and manufactures are returning. Machine tools are the heavyweights, as always, but developments largely due to the recent munitions activity are indicated by several of the exhibits. One of these is the increasing appreciation of the benefits of heat treatment in certain classes of work, and in this field much initiative has been displayed by the Canadian Hoskins Co., the well known pioneers in electrical furnace and pyrometer development. Their product now includes also gas-fired furnaces, ovens for enamelling, etc., and a unique product in the shape of Chromel, a non-ferrous alloy, which possesses marked non-corrosive properties, especially under the influence of heat. These properties are due to the high melting point of chromium combined with the great resistance of nickel to oxidization. This metal does not soften appreciably under heat like iron and has a life approximately 40 times as long. Applications already proven include carbonizing boxes, cyanide crucibles, lead pots, barium pots, pyrometer protecting tubes, etc.

It is of especial interest at this time to know that this alloy is made in Canada in the Hoskins factory, an important part of the process being played by a special type of carbon resistance furnace which is also exhibited. Its simplicity of construction and efficiency of operation render it particularly useful in high temperature work.

Further interest in the combustion field is stimulated by the extensive display of manufacturers furnaces exhibited by the Consumers' Gas Co. of Toronto. Apparatus and equipment for the convenient use of gas as a heat-producing agent in many lines of industry are shown in operation, gas and air being piped to most of the exhibits. High temperature furnaces for special steel hardening, tool room furnaces, ovens, brazing benches and blow pipes demonstrate clearly the adaptability of gas to many processes. The effect of several furnaces at white heat is very marked from a display viewpoint, the entire exhibited being markedly effective.

Of similar interest to visitors is the demonstrations of oxy-acetylene welding work. L'Air Liquide Society show the use of their apparatus in the manufacture of storage tanks for acetylene gas, to withstand 975 lbs. pressure per sq. in. A sample of liquid air, which is produced during the manufacture of oxygen was an item of more than ordinary interest, in which one could test the effects of 350 deg. below zero on the human flesh. Mechanical apparatus for the application of the oxy-acetylene flame to manufacturing operations were featured by the Carter Welding Co., who showed the well known Davis-Bournonville apparatus cutting steel plates of any thickness and shape. The radiograph is an ingeniously arranged machine on the pantograph principle, which enables patterns to be copied

THE CONSUMERS' GAS CO. EXHIBIT ED GAS FURNACES IN OPERATION.

on large or small scales, the flame cutting the outline as determined by the master design; the roughing out of dies and similar work is a particularly useful field for this device.

Special appeal is made to the skilled mechanic and fine tool maker by the Pratt & Whitney exhibit of Canadian-made cutters, reamers, taps, drills, shell tools and special articles of a similar nature. The prestige attached to the name is well upheld by this exhibit, which is convincing evidence of the possibility of producing such goods on a commercial scale within the Dominion. Complementary to the foregoing are the machine tool exhibits of Canada Machinery Corporation, Garlock-Walker Machinery Co. and A. R. Williams Co. Both wood and metal-working machines are displayed on a large scale by the former, whose annual appearance is looked forward to with interest by a wide circle of acquaintances. A feature of Garlock-Walker is the showing of numerous views in lantern slide form, illustrating iron machinery from the raw state to the finished product. The entire history of iron is shown from the blasting of the rock by the miners, through railroad yards, ore docks, blast furnaces, steel mills and foundries, pattern shops and machine shops till it assumes the form of a lathe, shaper or other machine tool, and demonstrates most convincingly the absolute dependability of modern manufacturing on this one metal more than any other. Suitable types of modern tools are on view to complete the exhibit.

THE CARTER WELDING CO. SHOWED MECHANICAL APPARATUS FOR CUTTING AND SHAPING PLATES WITH OXY-ACETYLENE FLAME.

CLEVELAND PNEUMATIC TOOLS INCLUDED SPECIAL DESIGNS FOR WOOD SHIPBUILDING.

A feature of the Williams exhibit is the demonstration of Stellite cutting tools on heavy forging machining. This wonderful alloy depends for its existence entirely on the Canadian deposits of cobalt, and during recent times has earned a wonderful reputation as a metal-cutting material. Numerous samples showing its application to tools for a wide range of operations are displayed by the Deloro Smelting & Refining Co.

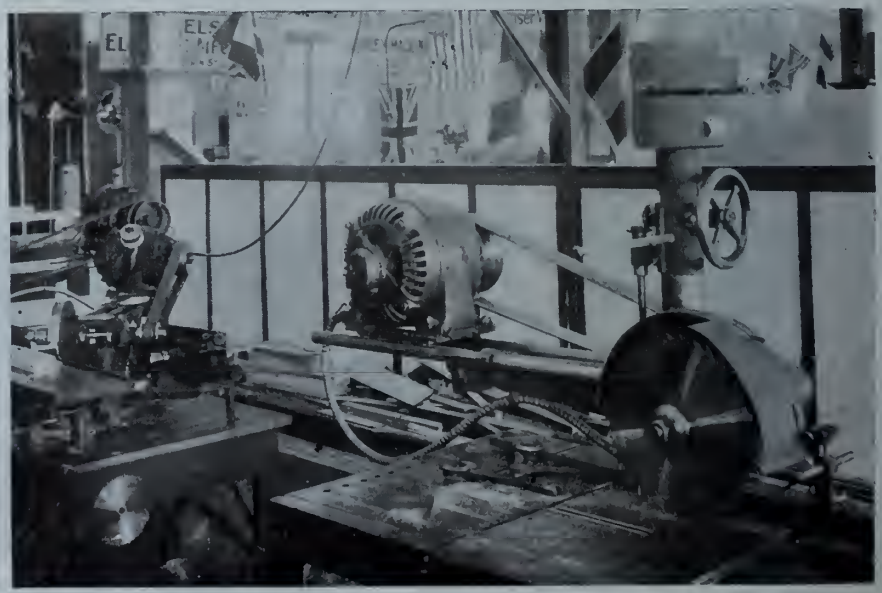
Pneumatic tools and accessories possess considerable interest in view of their labor-saving and cost-reducing ability. The development of shipbuilding both in wood and steel has been carefully studied by the Cleveland Pneumatic Tool Co., and special wood-boring machines and drifting hammers are featured by them in addition to their latest types of regular hammers and accessories.

Transmission equipment and apparatus is featured by the Dodge line, one of the items of interest being an exhibit showing their wood pulley in different stages of construction, from the plain board of selected lumber to the perfectly finished wood-split pulley seen on the shafting. Ball bearing developments are also well shown, the increasing recognition of this apparatus as an efficiency factor being evidenced by the presence of the Canadian SKF Co., Ltd., which makes a convincing demonstration of the extreme accuracy and high grade of workmanship in their product. The exclusive feature of self-alignment which is an inherent part of the design is shown by means of bent shafts, which revolve as freely in a fan draft as if they were straight and true. The Chapman Co. makes an effective display.

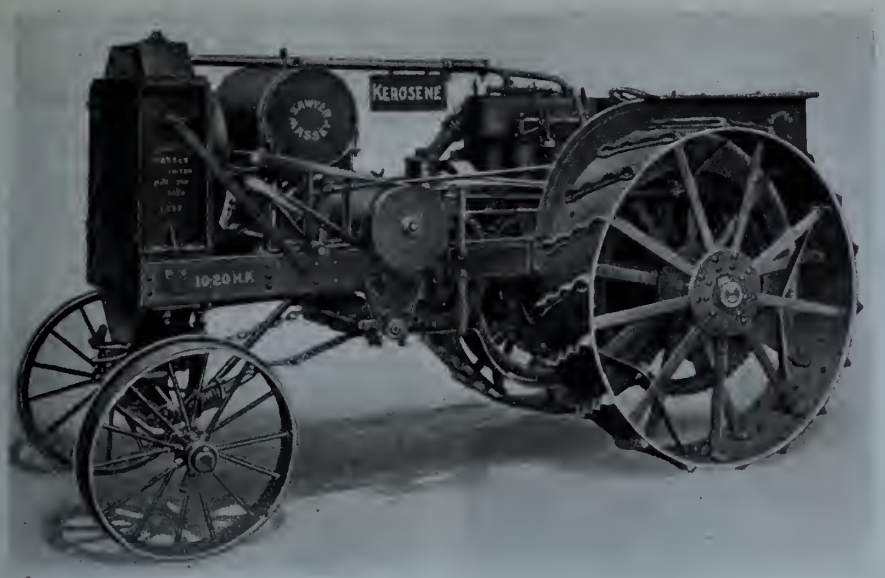
Belting exhibits are quite noticeable especially as most of the displays represent made in Canada goods. Of the four firms showing, each makes a distinctive type of product. Leather, rubber, and two varieties of stitched belting are available in weights, strengths, and finish for any kind of industrial need. Considerable local interest attaches to the two displays of that modern development of the saw bench known as the combination woodworker, one firm in particular having developed considerable business across the line.

The Goodyear Tire & Rubber Co. made an interesting display of a wide range of products, from heavy duty belting of large size to packing, jointing and similar engine room supplies.

Special interest attached to the exhibit of D. K. McLaren, Ltd., whose display of leather belting maintained their high standard of former years. Despite the present state of the leather market, they continue to feature the use of all British oak tanned stock in the belts which they manufacture, the superior strength, flexibility and long life of belting produced by this process being well



THE HUTCHINSON WOOD-WORKER PERFORMS LARGE VARIETY OF OPERATIONS.



SAWYER-MASSEY 12-22, 4 CYLINDER, KEROSENE DRIVEN TRACTOR.

known. Both balata and canvas belting were exhibited, suitable for power transmission and conveyor duty, while woolen and knitting mill supplies possessed features of interest to many power users. Both wood and steel split pulleys were also shown, together with a large variety of belt fasteners and lacing machines.

The Dominion Belting Co. showed their line of Canadian-made stitched cotton duck belting, in all sizes and weights for both conveyor duty and power transmission, along with belting accessories. The Main Belting Co. of Canada had also a very complete display of their product, which finds application in many fields of industrial activity.

Steam traps, boiler return systems, heaters, etc., were exhibited both in full size and models by the Geo. W. Cole Co., who showed a complete installation of a double trap taking care of returns from low pressure and high pressure systems simultaneously. A No. 7 trap to handle 600 horse-power was also shown, as well as condenser and three-valve types. The Cole system of packing was shown by means of a model trap.

Agricultural Engineering

Either engineers or farmers desirous of investigating farm apparatus which is the direct product of the machine shop find more than ample opportunity in the section devoted to this display. The present question of food control has thrown the production end further into the spotlight than might have happened in years, and the fierce blaze of criticism is turned loose on the numerous specimens of tractors, oil engines, pumps, electric lighting plants, along with other quasi-machine shop products such as milking machines, and similar products.

As a Canadian built product, the Sawyer-Massey line of tractors makes a special appeal. Simplicity of construction has been combined with convenience and efficiency of operation in a markedly successful degree. The 4 cyl. vertical automobile type of motor is placed near the rear axle to give maximum adhesion, and allows the transmission case and jack-shaft to be placed amidship in a most accessible position. The clutch likewise benefits thereby, while the train of reducing gears to the driving wheels is also made very accessible. Approved

EXHIBIT OF CANADIAN S K F CO., SHOWING DISTINCTIVE FEATURES OF THEIR SELF-ALIGNING BEARINGS AT CANADIAN NATIONAL EXHIBITION.

EXHIBIT OF GEO. W. COLE, LTD., STEAM SPECIALTY MANUFACTURERS, WHO SHOWED APPARATUS IN OPERATION.

design of steering gear with spring buffers is fitted to front wheels. Water cooling with fan radiator is incorporated in the design in a suitable manner the radiator construction being exceptionally robust. The motor is 4 in. bore by 6 in. stroke running 700 to 1,000 rev. per min., and gives 22 horse power at the belt pulley and 12 at the draw bar. Two speeds of 2¼ and 3½ miles per hour are provided, while weight of 5,200 lbs. enables three to four plows to be operated.

Allis-Chalmers exhibited a 10-18 horse-power machine of the three-wheeled type, the single front wheel following the furrow automatically and relieving the operator of much of the steering effort. It is operated by a 2-cyl. opposed type motor, 5¼ by 7 inch at 720 rev. per min. and weighs 4,800 lbs. The frame is a one-piece steel casting, heat treated, while the radiator is of the automobile type with centrifugal pump.

OAK TANNED LEATHER BELTING WAS A PROMINENT FEATURE IN THE DISPLAY OF D. K. McLAREN, LTD.

The 9-18 Case tractor was shown by the Fairbanks-Morse Co., and attracted attention through its compact and wonderful hill climbing ability demonstrated on a 35 deg. incline. As illustrated the motor which is 8 cyl. vertical, is placed athwartships so as to obtain straight spur drive to rear axle. The front axle is pivoted vertically at the centre, with steering knuckles on the wheels. A truck type of radiator is fitted in conventional manner and has gear driven fan, and centrifugal pump circulation. Heavy duty roller bearings are used wherever desirable, including the transmission, and rear axle, and an oil tight housing encloses the bull pinion and gear. Two speeds are obtainable, along with ample power to pull two 14 in. plows.

CASE 9-18 AUTOMOBILE TYPE TRACTOR WITH 4-CYLINDER MOTOR PLACED TRANSVERSELY.

Good advice for power plant men—when in doubt, don't do it; be sure you're right, then go ahead.

ALLIS-CHALMERS THREE-WHEELED TRACTOR IN OPERATION ON A FARM.

PREPARING HEATING BOILERS FOR SERVICE

AS the winter season approaches, householders and other owners of heating boilers begin to make plans for placing the boilers in service. Persons who earnestly desire to obtain the best results from their heating plants, and who give careful thought to securing economy in operation and obtaining maximum length of service from their equipment, — in other words, all thrifty and methodical managers,—will have had their boilers well cared for at the time their operation was discontinued in the spring, so that in restoring them to service there will be little to do except to close up the various openings, supply the necessary water and start the fires.

The precautions that should be observed in laying up boilers, in the spring, were outlined in the Travellers Standard some three years ago. Commenting on the preparation of boilers for service, it says: If these have been faithfully observed the boilers should be in good condition in the fall, both internally and externally; but if they have been neglected, the delay has doubtless affected the heating equipment detrimentally, so that any defects that existed in it have probably grown worse, and deteriorating influences of various kinds have doubtless produced notable results during the period of idleness. In such cases, therefore, it is important to look the heating plant over with special care, to remedy the effects of neglect as far as possible. Some of the advice that is given below is based upon the assumption that the boiler was not properly cared for in the spring, and other parts of it should be heeded, whatever was done at that time. The reader will have no difficulty in distinguishing the parts that apply to his own case.

Internal and External Cleaning

Before filling the boiler with water, clean every accessible part of it thoroughly, both internally and externally. Take down the smoke-pipe and remove the soot from it, and in the case of tubular or flue boilers thoroughly clean out the tubes or flues. When the smoke-pipe has been replaced, examine the joints carefully and make sure that they are tight, and give attention also to the supports for the pipe.

An equal amount of care should be exercised in cleaning the external surfaces of the boiler itself. All soot, dust and ashes should be removed from the setting, boiler and grates. See, also, that the brickwork of the setting is in good repair.

Do not forget that the gage-cocks and the connections to the water column may have become filled up. Make sure that they are free, even if it is necessary to remove them from the boiler for the

purpose; and in the subsequent operation of the boiler do not rely upon the water glass to implicitly for determining the height of the water, but confirm its indications by the frequent use of the gage-cocks.

Attention to Corroded Parts

If the water was drawn off in the spring without drying out the boiler afterwards, or if the feed valve has leaked during the summer, small quantities of water may have remained upon the boiler surfaces for a considerable time. In this case corrosion and pitting have doubtless occurred to some extent. All areas affected in this way should receive special attention. If possible, the water should be removed, with a mop or otherwise, and the metal allowed to dry. The plates should then be scraped, or thoroughly cleaned with a stiff wire brush, and it is often well to paint the affected places with red lead and oil, or with some special protective preparation, after the dirt and oxide have been entirely removed. When this has been done, and sufficient time has been allowed for the paint or other protective substances to dry, the boiler should be filled with water and drained off again at least twice; and if the construction will permit, a hose should be used to wash out any sediment that may remain. In filling the boiler leave a vent open somewhere, for the escape of the air it contains. Opening the upper gage-cock suffices for this purpose, if the boiler is to be filled only to the working level; but if it is to be completely filled, the safety-valve should be eased from its seat, or some other opening should be left at or very near the top of the boiler to prevent the trapping of air in the upper part of the boiler.

Whenever it is feasible to do so, the safety-valve should be tested by hydrostatic pressure before the boiler is placed in service, to see that it operates at the pressure for which it is supposed to be set.

Look over the boiler accessories and attachments with special care. Raise the safety-valve from its seat, and if it does not work freely, or if any part of it is in need of repair, see that the trouble is made right before firing up the boiler. The diaphragm of the automatic damper regulator also requires a critical examination. See that it is soft and pliable, and if it is found otherwise, have it removed and replaced by a new one. See. also, that the diaphragm, with its connections and the dampers that it regulates, works smoothly, easily and positively.

Starting Up

The fire should be run very low at the start, to permit the boiler and its contents, and the various other parts of the system, to become heated up gradually. The supply and return valves of the heating system should be opened so that the steam, as soon as it is generated (or the hot water if the system is of the hot-water type), will warm up the pipes gradually. Pounding in the pipes will be averted in this way, and the danger of rupturing the cast-iron fittings by rapid and unequal expansion of the piping will also be diminished. As soon as steam has been raised, the safety-valve should again be lifted, to see that it is free and in good working order. It is also well to run the pressure up to the point at which the safety-valve is supposed to blow, in order to make sure that it will operate properly under regular running conditions.

Skilled Examination Necessary

The boiler owner or attendant who has faithfully complied with the foregoing suggestions may feel reasonably confident that his boiler is in condition for safe and efficient service, unless the deterioration that it has experienced during the summer season has been very marked. It will probably give no trouble if it is in charge of an experienced and trustworthy attendant, who will see that it is properly supplied with water, and that the safety-valve, damper regulator and other accessories are kept in good working order. It is important, however, to have the boiler examined by a competent inspector, who will look over the entire equipment thoroughly, to make sure, so far as possible, that everything is in good condition, and to test and regulate the safety-valve and the steam-gage. Many boiler insurance companies render service of this kind to their policyholders, free of charge; and also give valuable expert advice on all matters relating to boiler management. The counsel that is given in this article will prove helpful in promoting safety and economy, but no article could be written that would make it wise to dispense with the services of an experienced inspector. One might as well dispense with his family physician, after reading a little of the elements of physiology and materia medica.

The Second-Hand Boiler

A considerable number of second-handed heating boilers will doubtless be installed at about this time, and many that are in poor condition, or even positively dangerous, may be accepted by inexperienced persons, upon the representations of unscrupulous or misinformed salesmen. A coat of paint often makes a poor boiler look good to a novice. Here, also, the services of insurance inspectors are valuable, because their training enables them to detect weaknesses and defects that would easily escape the attention of persons with less experience.

GRAPHITE REMEDY FOR BOILER SCALE

A VERY finely powdered graphite placed in a boiler immediately after it has been cleaned, circulates with the water, and rubs against the steel, to which it imparts a graphite finish or polish on which scale does not readily form. When this initial dose is regularly followed up by smaller doses, the graphite, by mechanical, not chemical, action gradually softens and disintegrates any old scale that may still be present, and if new scale thereafter forms, and it almost always will to some extent, it forms in and with that scale, so that all may be easily broken up and removed. Inferior grades cannot with safety be allowed into steam boilers.

The graphite in cheap grades is impure, containing, perhaps, only 20 to 50 per cent. graphite carbon. The impurities consist of clay, silicate, etc. which means that for every 100-lb. used there would go into the boiler from 50 lbs. to 80 lb. of scale-forming substance, which, with the impurities in the feed-water, would be too much for the 20 lb. to 50 lb. of graphite carbon to influence. The cheap grades are, also, coarsely ground. Graphite, to do the work properly in a boiler, should be so impalpably fine that it will remain suspended in the water and circulate with it. Amphorous graphite gives the best results, both for lubricating and for removing and preventing scale. Flake graphite will not do the work as well. The graphite mined in Mexico is said to be the best for steam boilers.

OBSERVATIONS ON ROPE DRIVE PRACTICE

IT occurs to us that conditions and circumstances enter more largely into the determination of the various details constituting a rope drive than have to be accounted in that of a belt drive, therefore the following notes and observations on rope drive practice may be found interesting and useful:

Manila and cotton are the materials generally used for rope purposes, and may be constructed of 3 or 4 strands. The rope diameters in practice vary from 1 to 1¾ inches, although those below 1½ inches are somewhat uncommon. From investigation it has been computed that the safe and economical dorking strain for a 1 inch diameter rope is 200 pounds, with equivalent for other sizes. Rope wear is both internal and external, caused in the former by the movement of the fibres on each other, and in the latter by slippage and wedging in the pulley grooves. This wear, of course, is normal, and is dependent on the speed of drive.

As in belt drives the advantage lies with large diameter pulleys, the tendency being to less internal wear, due to fibre sliding decrease, with diameter increase. Care should be taken to have the grooves ground out smooth and of unbroken surface, so as to obviate unnecessary wear or tearing of the external surface of the rope. The groove angle may be 45 to 60 degrees. Rope wear is independent of pulley distance apart, because it takes place on the pulleys only; at the same time distance is a factor in first cost.

Experience goes to show that 80 feet per second is the speed at which the maximum horse-power is attainable; speeds beyond this having the horse-power output reduced by centrifugal tension. Cotton ropes require less lubrication than do Manila ropes.

THE slab forging for the crankshaft of a 125-horsepower airplane engine weighs 605 lbs. The finished shaft weighs 46 lbs. The forging, of chrome-vanadium steel, costs over $200.00.

Brief Historical Sketch of Steam Boilermaking in Canada

By D. M. Medcalf *

The development taking place in our shipbuilding industry, more particularly that of steel construction, and the intimate relationship that exists between it and steam boiler building, make a retrospect of the associated crafts' achievement in Canada peculiarly opportune and interesting meantime. The article embodies the substance of an address delivered before the American Boilermakers' Association at their recent Annual Convention.

WHEN choosing this subject, I hoped to be able to obtain some assistance from the compilations of historians who have linked together the memories of past and present industries in Canada, but have been disappointed because they have overlooked the existence of the black squad who toiled in an unpretentious way, building steam boilers for our early industries. These horny-handed sons of toil appear to have passed away unhonoured and unsung, and their memories have been almost forgotten, save by a few of our old boilermakers and engineers. I have, therefore, decided that, rather than go into the details of construction in this paper, to treat the subject more in a general way.

Doubtless, the first boilermakers in Canada were located around the eastern seaboard. In the early part of the eighteenth century, settlements clung close to river, lake and sea, and the St. Lawrence, the St. John, and their tributaries, besides other lesser rivers, provided inevitably the points of settlement and the lines of travel. The development of water transport in Canada is interesting and furnishes a record of need, invention and enterprise, and not the least among these was the advent of commercially successful steam navigation.

Advent of Steam Navigation

First came the bark canoe, large enough to hold a few voyagers and peltry, and for a long time it held its place for the far journeys. For shorter travels, the canoe was superseded by the larger, but clumsier, bateau. In later years, the increase in river freight led to the introduction of the still larger Durham boats, whilst along the coast and on the great lakes the sailing schooner long filled a notable place. Finally the steamboat came in 1839. Only one year after the Clermont had begun its regular trips on the Hudson, there was built at Montreal the forty-ton steamer Accommodation, and seven years later the Frontenac, of about seven hundred and forty tons displacement, was launched.

It is noteworthy that the first steamship to cross the Atlantic without auxiliary aid was built in Montreal. This vessel was called the Royal William, and left Canada on the 5th August, 1833, for London, and arrived there about one month later. Our early Canadian boilermakers were, therefore, amongst those pioneers who not only developed water transport in Canada, but inaugurated ocean steam navigation. Marine boilers at that period were built rectangular in form of the marine flue type, carrying from 10 to 20 lbs. pressure. Boilers of this type, with certain modifications in design, were in vogue for a considerable time, and gradually developed into the Scotch marine type, with which we are all familiar. The development of these boilers was, of course, due to the efforts of Scotch engineers on the Clyde.

Boiler Types

With regard to the manufacture of boilers in Canada, around 1850, there were quite a few of the old pioneers engaged in this work. A list of names would perhaps be of little interest now,

D. M. MEDCALF.

but I mention the following firms who are still extant:—

E. Leonard & Sons, London, Ont., established 1839.

Waterous Engine Works Co., Brantford, Ont., established 1840.

John Inglis Co., Toronto, Ont., established 1859.

John McDougall, Caledonian Iron Works, Montreal, established 1858.

Goldie & McCulloch Co., Galt, Ont., established 1844.

Besides these, there was a large number of thriving little boiler businesses, long since petered out, like the Dicky Neal and John Perkins boiler works of Toronto, Joseph Hall, Oshawa, etc.

Pioneers in the Craft

In those early days, that is, sixty or seventy years ago, the types of boilers generally in use were externally fired with three to five flues, 8 to 10-in. diameter. There has been little development in this type of boiler, and the H. R. T. in use to-day is typical of the boiler used then. The diameter of these boilers seldom exceeded 54 inches, but what they lacked in girth, they made up in length, as twenty to twenty-five feet was no uncommon stretch for those old stagers. The seams were all of single-riveted, lap construction, and the plates ranged in thickness from ¼ in. to ⅜ in. The shell rings and also the tube rings were telescoped one into the other, like stove piping. They were very strong on domes at that time, and I believe a boilermaker then did not think he was building a boiler at all, unless he had a huge dome on the outfit. Most of these early domes were cast iron, and some of our manufacturers adhered to this style of dome until as late as 1890, in which connection I venture to say a good many explosions have resulted from these castings fracturing, two accidents of recent date coming under my own personal notice.

Materials of Construction

With the exception of the domes of some of these boilers, wrought iron was the material almost exclusively used in their construction. The brands of iron were Lowmoor, Yorkshire, Bowling, Thornycroft, etc., all imported from the British Isles. As a rule, the plates were short and measured about 4 ft. 6 in. square. These sheets were soft and ductile, but blisters or laminations were not infrequently met with, which caused considerable loss and inconvenience. Another imperfection was that of spongey parts, generally due to imperfect puddling, but, notwithstanding these defects, the old iron boilers gave good service, and we have many still in service, after thirty or forty years of general wear and tear. The majority of the boilers then were used in saw mills and flour mills, and were often employed to augment the power of a water wheel. The steam pressures carried were low, and forty to fifty pounds was looked upon as a very high pressure indeed. Fuel was cheap, as wood was plentiful, but coal was very scarce and seldom used, except by the blacksmith in the smithy fire, and the moulder in his cupola.

Our plate rolls were originally made of wood and were operated by hand. This, of course, was only made possible by the size and thickness of the sheets

*Chief Inspector of Steam Boilers, Province of Ontario.

used at that time. Punching was done by hand with a screw or bear punch, and sometimes as many as four men were employed at a time to pull on the punch lever. All holes were punched full size, and those that did not come fair enough were usually persuaded into alignment by the gentle assistance of drifts and sledges. Sometimes a taper reamer was used, but this was the exception, rather than the rule, and any holes which could not be reached with the punch were cut with a round-nosed chisel. The head plates were flanged with large wooden mauls over cast iron flange blocks of the required size. It was customary to make the heads a little undersize, so that they could be drawn out gradually to the exact diameter.

Heads were dished in a very crude manner by digging a hole in the ground, somewhat resembling the desired curvature of the head. The circular plate was then heated and beaten down into this hole with wooden mallets, the finishing process being accomplished by flatteners and sledge hammers. It sometimes happened in the case of heads dished to a deep camber that the work could not be done in this way, and a large cast-iron ball was often used to advantage. This ball was hoisted a certain distance, then dropped on the red-hot plate in much the same way as a pile driver.

These—what now appear to us—crude methods of the early boilermakers have undergone a vast change in the last fifty years. The up-to-date machinery now in use for every branch of this industry has almost entirely superseded hand work, and there is just reason to be proud of the modern steam boiler which our manufacturers are turning out to-day in large quantities. We must not, however, despise the useful work of our predecessors, for they built many good boilers in those good old days.

Boiler Inspection Feature

We have a large number of boilers in Ontario that were constructed before the present Act governing the construction of boilers came into force and took effect, which were built in a thorough workmanlike manner. We also have some that are not so good, and they were not all built in Canada, but since the enactment of the present law, we are quite satisfied that better boilers are now being turned out, and the purchaser is safeguarded as far as workmanship and material is concerned.

No matter how rigid the inspection, it is not a guarantee that the boiler will not explode, because it largely depends upon the care and attention the unit receives when in operation, how long it will remain in useful service. Quite recently, I was requested to make a personal examination of two 66 in. x 16 ft. H. R. T. boilers that had been seriously damaged. The boilers referred to were built from an approved design and inspected during construction; the shell plates were fabricated by one of the largest plate manufacturers in the United States, and were carefully examined before any work had commenced, the heat numbers and tensile strength recorded and passed as being suitable for a steam boiler. The workmanship was also examined during the entire construction, and upon completion, the boiler was passed, and certificates issued in the regular way. After these boilers had been in service six months, they each developed bags on the sheets directly over the fire, extending four inches down, three feet wide and five feet long, and on account of their being practically new, the owner claimed that the cause was poor material and workmanship, and I personally acted as a referee in the settlement.

When I visited the plant, and when trying to squeeze into the regulation inspector's outfit—which is now too small for me—I requested the owners to have the manhead under the tubes removed. The manhole in top of shell was open and ready for the inspector. Immediately the light was flashed on, the interior of the boiler, it was quite apparent what caused the trouble. The water that lay in the depression was covered with black spots, and the tubes and shell, as far as could be seen, were coated with oil.

It was at first a difficult matter to convince the owners that oil had caused the trouble; it was a new plant, and oil they claimed could not get into the boiler because they had installed an expensive oil separator in the exhaust line from the feed pump, which was the only steam line returning its condensation to the boilers. A further examination was made by disconnecting the oil separator, which was found quite clean, but beyond the outlet a full handful of grease was collected and shown to them, with the result that they were quite satisfied that they themselves were to blame, and not the poor manufacturer, who made the boilers to comply fully with the requirements of the Province of Ontario. The necessary repairs cost about $2,500 and considerable inconvenience to the operation of the plant.

I could cite a number of cases very similar to this one, but believe there is "nuf sed," and my object in mentioning this fact is because frequently when trouble develops, and the cause of same is not known, it is blamed on the rotten old boiler made by so and so, who is really blameless.

War Effect on Canadian Boiler Making.

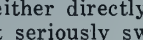
Now, in regard to the effect of the war on the boiler-making industry in Canada, I might say that its penetrating influence has affected almost every industry we possess, either directly or indirectly, and the most seriously swayed of these have been engineering and allied trades. Almost since the beginning of the war, or, to be correct, since the Governments of the Allies began to place orders abroad for the supply of munitions, most of our boiler shops have been partly converted into munitions factories, whilst our machine shops are similarly engaged, running night and day.

Besides making shells, however, our boiler shops are turning out boilers in fairly large numbers, not only for domestic use, but for export trade, chiefly to the Allies, and we have orders for many more which cannot be supplied by reason of our inability to obtain the necessary material. It is true, therefore, that the war has increased the output of our boiler works, and it is also true that the war is retarding that output, owing to the scarcity of steel, or, to be correct, owing to this merchandise finding a more ready outlet in another channel; a large number of the mills, I believe, who are working on metals have sold their full production one year in advance for war purposes.

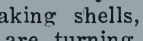
Dearth and Cost of Steel

The dearth of steel, however, is not the only obstacle. The price of steel, as you all know, has been going up with leaps and bounds since the war began. Labour conditions are also very bad, and good boiler makers to-day cannot be had in anything like sufficient numbers to cope with the increase in business. From the beginnig of 1915 to the present time, but more especially in 1915 and 1916, a large number of munition factories and like industries, which were urgently required to meet the existing crisis suddenly sprung into being, and consequently more boilers were required. Our manufacturers having only their usual stock of plates and tubes on hand were very soon unable to supply the goods until more material was forthcoming, and this occasioned much delay. Those factories, therefore, which urgently required boilers turned their attention to the second-hand market, and used boilers were largely sought after. Old boilers of all descriptions were painted up and offered for sale as good boilers, and, needless to say, many were condemned by our department. These scrap boilers have in turn found their way to the furnaces to be melted into shell billets, and latterly shipped to Germany via France. Perhaps a part of one of our old boilers, after undergoing this transformation, may yet find a resting place in the Kaiser or the Crown Prince.

The demand of late has not been so much for stationary boilers, as for marine boilers, and our manufacturers are harder pressed now than ever for steel plates and tubes, and, although they are turning out a lot of work, the demand by far exceeds the supply. If we only had steel plate mills of our own in Ontario, it would have been of great assistance at this period, but unfortunately we are not sufficiently advanced along those lines, and have to depend entirely on imported material.



Instead of Babbit Metals.—As a substitute for babbit metals an inventor proposes to use mixtures of metallic sulphides in widely varying proportions. He considers that the sulphides of copper, lead, tin and antimony make good babbitt substitutes. Metallic sodium is used to improve their casting properties.



It is not commercially possible to burn more than 99 per cent. of bituminous coal fed to the furnace.

High Pressure Air Compressor Design and Application*

By Joseph M. Ford

Compressed air at high pressure is becoming an increasingly important medium in modern engineering practice and in naval warfare. The accompanying paper deals with the machines which produce high pressure air, leaving on one side the question of power transmission by compressed air. In passing, the principal advantages of this system are referred to, and will be seen to be of considerable value. They consist of the facility with which energy can be stored; the unlimited rate at which accumulated energy may be converted into useful work; and, apart from loss of efficiency, leakage cannot cause any awkward consequences.

THROTTLING

IN a compressor which has its suction throttled, the volumes dealt with by the stages are of course reduced, which naturally involves a decrease in stage pressures. In a compressor with no cylinder clearances there would be no limit to the possible compression ratio in any cylinder; that is, the initial pressure in, say, the high-pressure cylinder could be very low and yet the machine would deliver air. In a cylinder with a large clearance, however, there is obviously a definite limit to the ratio of compression if air is to be delivered. If this ratio were exceeded, the air would simply be compressed into the clearance space and re-expanded. In other words, in order that the compressor shall deliver air, the intermediate-pressure delivery pressure must attain a definite figure, so that the total work is still divided between the stages, although not necessarily in correct proportion. The theoretical minimum initial pressure from which a cylinder can compress and just deliver (assuming no leakage) can be obtained from the equation:—

$$c\left[\left(\frac{P_1}{P_2}\right)^{\frac{1}{n}} - 1\right] = 1$$

where

c is the clearance ratio,

P_1 is the delivery pressure (lb. per sq. in. absolute),

P_2 is the minimum initial pressure (lb. per sq. in. absolute),

and

n is the exponent in PV^n=constant.

The above expression shows that P_2 increases as c is increased, and that with large clearances the compression ratio in any stage when the compressor is running throttled can be kept within limits, whereas in a machine having very small clearances the high-pressure compression ratio, with excessive throttling, might reach an abnormal figure, resulting in excessive temperatures in that cylinder. The foregoing would tend to show that a compressor with good clearance volumes is preferable to one with small clearances, and for some Diesel engines — especially those of the marine type, where the conditions under which the compressor works may vary between fairly wide limits—this is the case.

As previously mentioned, clearance results in a reduction in the effective capacity of a cylinder, so that larger cylinders must be fitted than would be necessary with no clearance volume. The direct result is an increase in the piston loads. For example, a compressor of 300 cub. ft. per minute displacement at 350 r.p.m., having stage pressures of 45 and 300 lb. per square inch, when working at 900 lb. per square inch delivery pressure, and cylinder clearances for low pressure, intermediate pressure and high pressure of 4, 5 and 10 per cent. respectively, has a maximum air load on the high-pressure piston of about 7,900 lb., whilst the maximum intermediate pressure piston load is 14,300 lb. In a similar machine having, however, low pressure, intermediate pressure and high pressure clearances of 4, 15 and 30 per cent. respectively, the high-pressure piston load is increased to 12,100 lb. and the intermediate pressure load to 22,800 lb. Figs. 12 and 13 give for various clearance ratios the maximum piston loads for compressors of the above capacity and stage pressures.

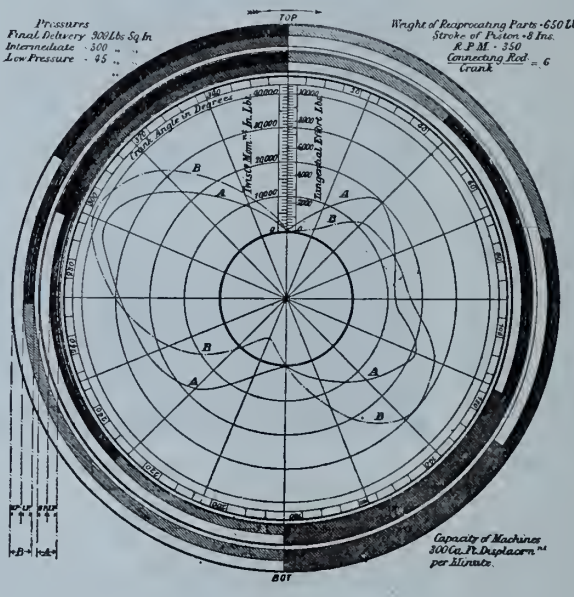

Pressures
Final Delivery 900 Lbs. Sq. In.
Intermediate · 300 ·· ··
Low Pressure · 45 ·· ··
Weight of Reciprocating Parts · 650 Lbs.
Stroke of Piston · 8 Ins.
R.P.M · 350
Connecting Rod / Crank = 6
TOP
Crank Angle in Degrees
Thrust Norm.l to Line
Tangential Effort Line
Capacity of Machines
300 Cu. Ft. Displacem.t
per Minute.

FIG. 15.

Diagram of twisting movements and crank angles for various events of the cycle. A—For a machine with clearance volumes —L.P. 4 per cent., I.P. 5 per cent., H.P. 10 per cent. of volume swept. B—For a machine with clearance volumes—L.P. 4 per cent., I.P. 15 per cent., H.P. 30 per cent. fo volume swept. Final delivery period, black; re-expansion of clearance air, single hatching; suction from intercoolers, circular hatching; transfer periods, cross hatching; compression periods, blank. The diagram from the L.P. points will be practically identical for the two machines, and is therefore not given.

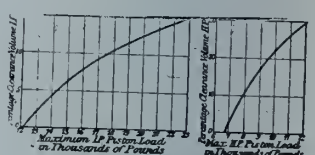


FIG. 12. FIG. 13.

Diagram showing effect of clearances on piston loads for a given output at a given pressure.

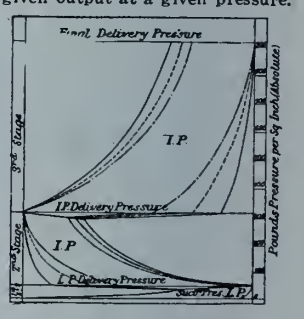


FIG. 14.

Combined diagrams for three machines designed for same output and stage pressures.
For a machine with clearance volumes—L.P. 4 per cent., I.P. 5 per cent., H.P. 10 per cent. of volume swept by piston.
For a machine with clearance volumes—L.P. 4 per cent., I.P. 10 per cent., H.P. 20 per cent. of volume swept by piston.
For a machine with clearance volumes—L.P. 4 per cent., I.P. 15 per cent., H.P. 30 per cent. of volume swept by piston.

Fig. 14 shows the combined indicator diagrams for three machines, whose pressure characteristics are shown in Figs. 12 and 13. Inspection of the diagrams super-imposed shows that as the clearance is increased the commencement of delivery and the commencement of suction, in both the intermediate-pressure and high-pressure cylinders, occur later in the stroke. With a large clearance, therefore, the maximum cylinder load is not attained until the crank is at a somewhat smaller angle from the dead centre than would be the case in a machine with no clearances, due to the fact that the actual compression takes place during a longer portion of the stroke, and further, the re-expansion of the greater volume of clearance air occupies a larger portion of the stroke, so that the pressure acting on the piston does work on the crank through a greater angle than it would were the cylinder clearances small. The crosshead load (neglecting inertia and weights of parts) at any point in the stroke, for the particular type of machine under consideration, is the difference between the intermediate-pressure piston load acting upwards and the low-pressure and high-pressure loads acting downwards, so that with the increased clearances the greater loads in the high-

*Part II. of a paper read before the Greenock (Scotland) Association of Shipbuilders and Engineers.

pressure and intermediate-pressure cylinders tend to balance one another to some extent. The result of this is that although the actual piston loads are considerably increased with large clearances, yet the maximum turning moment is augmented to a much less extent.

Fig. 15 gives the turning moment diagrams for two of the three compressors previously mentioned, namely, that with the 10 per cent. high-pressure clearance and that with the 30 per cent. high-pressure clearance. It will be seen that the maximum value occurs in this case when the crank is about 65 deg. from top centre. The comparatively small increase in maximum turning moment with the larger clearance, compared with the increase in the actual piston loads, is to be noted. The effect of the increased clearance volumes on the crank angles at which the various events of the cycle occur is also clearly seen.

Fixing of Stage Proportions

When a machine is required to deliver a given quantity of air at a given pressure, one of the first decisions concerns the number of stages in which the compression should be effected. The main factors are: the initial cost of the machine, reliability and economy in operation, and safety in operation.

The initial outlay increases as the stages are multiplied. With a small machine the gain in economy and safety in operation due to increasing the number of stages is of less importance than in a large one. Cooling will be more effective due to the smaller cylinders, and the castings will probably be more reliable, thus lessening the chances of breakdowns. In addition, piston leakage in a small two-stage machine will probably be much less than in a three-stage machine of similar capacity, because in the former there will only be leakage past two sets of rings, whereas in the latter there are three sets. Moreover, the high-pressure piston in the two-stage compressor will obviously be larger than that of the three-stage one, so that the piston rings are much more likely to be air-tight. It is a recognized fact that in practice small rings, in spite of the smaller circumference, are more difficult to make tight than large ones.

The necessity for reliability demands, for reasons previously mentioned, that the temperatures in the cylinders be kept as low as possible, which in large machines, where the cooling is comparatively poor, demands division of the compression into several stages.

An important point in the computation of stage proportions is to arrange as far as possible for equal temperatures in each stage, for then the highest temperature is a minimum. Theoretically, this can be attained by dividing the work equally between the stages—which also results in the minimum of work required per unit of air compressed. In practice this is only true when the cooling effect is the same for all stages and the intercooling perfect.

Fig. 16 shows the theoretical theta-phi diagram for a three-stage compressor delivering air at 900 lb. per square inch gauge pressure. With equal division of work between the stages and intercooling down to the initial atmospheric temperature, the heat equivalent of the work required per lb. of air is represented by the area under ABHMPGR down to the line of absolute zero temperature (diagonal shading). The cooling effect is assumed to be the same for all stages, and as a result it will be seen that the miximum temperatures attained are the same for each stage of compression., 260 deg. F. The distance a, b, and c are, of course, equal, since the compression ratios of the stages are identical.

Supposing that, owing to restricted water supply, climatic conditions, or circumstances connected with the design of the machine, it is found that in the first stage intercooler the air can only be reduced in temperature to 90 deg., and in the second stage intercooler to 120 deg., then the diagram is modified as shown by the dotted lines. The heat equivalent of the work required per lb. of air will then be represented by the area under ADJLOGR down to the line of absolute zero temperature, the excess over the previous case being represented by the horizontally shaded portions. The temperatures attained in the stages are no longer equal, but increase towards the final delivery. In this case they are: low pressure = 260 deg., intermediate pressure = 300 deg., high pressure = 340 deg. The compression ratios of the stages are, however, still equal.

With the poor intercooling, even, the maximum temperature of the cycle can be reduced by changing the distribution of work between the stages.

If the compression ratios in the various stages are made in the proportion x : y : z (see Fig. 16), then the stage temperatures will be the same, and consequently a minimum, although the intercooling is bad and the work distribution unequal.

The modification to the temperature-entropy diagram for these latter conditions is indicated by the chain-dotted lines, and the work in this case is the area under ACFKNER down to the absolute zero of temperature line. This is found to be slightly less than that required for the previous case, in which the compression ratios were equal. In some cases, therefore, better results are obtained from an unequal distribution of work than would be the case were each stage given an equal share, and also it may be pointed out that probably more valve trouble results from excessive temperature than from any other cause.

The design of certain machines is such that the cooling in some stages is likely to be very much better than that in others, in which case the work in the well cooled stages can be increased, and thereby relieve to some extent the stages with inefficient cooling.

Fig. 17 shows approximately the entropy diagram which would be obtained from a test on one of the machines previously referred to, namely, that with the low-pressure clearance 4 per cent., intermediate-pressure 15 per cent., and high-pressure 30 per cent. of the piston displacement.

It is not proposed to enter into the question of the application of the theta-phi diagram to air compression. The peculiar shape of the lines representing the change from the initial condition to the final condition at end of compression is due to the transfer of heat from the cylinder walls after compression has commenced and to the heat added to the air as a result of piston friction. The deviation to the right of the vertical indicates that the air temperature is rising even faster than with adiabatic compression as a result of the addition of the said heat. Later on in the stroke cooling sets in and the compression becomes further removed from the adiabatic, shown by the line bending over to the left.

The atmospheric temperature is assumed to be 60 deg. F. The point "X" represents the initial condition of the air in the low-pressure cylinder just before compression begins, and it will be observed that the temperature has been increased by the amount delta t_1 (in this case 20 deg.), the increase being due to the fact that the air on its way to the cylinder has become heated through contact with hot valves, etc. In this particular case, with a mechanically controlled suction valve, the initial pressure is seen to be very slightly above 14.7 lb. per square inch, due to the inertia of the moving column of air in the suction pipe.

The first stage compression is carried to 59.7 lb. per square inch absolute and the temperature rises to 320 deg. F., the large rise being due to the fact that cooling is rather bad in this stage, partly as a result of a large portion of the "cover" being occupied by the high-pressure cylinder and the rest by large delivery valves, so that cooling cannot well be applied to this part. From the diagram it will be seen that the resultant compression is almost adiabatic.

After the first stage of compression the air is cooled in the intercooler to 80 deg. F., but on entering the second stage cylinder it again increases in temperature delta t_2 due to the hot piston, passages, etc., and also as a result of mixing with the re-expanded clearance air. The restriction in the intercooler tubes and in the valves results in a pressure drop, so that the initial second stage pressure is somewhat lower than the low pressure delivery pressure.

The total effect, then, of the above is that the initial condition in the second stage cylinder is represented by point "Y" in stead of point "J," as would be expected.

It is assumed that the large clearance space in the intermediate-pressure cylinder is well cooled, and this, together with the good packeting effect, results in the compression being further removed from the adiabatic than it is in the low-pressure cylinder, so that in spite of the considerably greater share of the work done by the intermediate-pressure, the temperature of compression is not very much in excess of that in the previous stage. A similar sequence of events takes place in the high-pressure cylinder, where, again,

owing to the large well-cooled clearance, compression is within the adiabatic. This, together with the fact that the high-pressure stage has the smallest share of the work to do, results in the comparatively low final temperature of 240 deg. F.

Even with a poor distribution of work, as in this case, the temperatures need not necessarily be excessive. There are, however, other aspects of the problem of determining stage proportions. Consider the case of a high-speed Diesel engine compressor, where it is desirable that the balance and twisting moment diagram of the machine should be as good as practicable, in order as far as possible to eliminate vibration.

With a machine of a certain type, it will be obvious that the crosshead load at the top centre will be due to both the low-pressure and high-pressure delivery pressures on their respective pistons, whilst at the bottom centre the load is only that due to the intermediate-pressure pressure. The maximum upwards load is then about twice the maximum downwards load, which would not conduce to the best running.

There are two ways of bettering conditions, one of which is to retain the stage pressures and adjust the intermediate pressure clearance until the load approximates to that desired (see Figs. 12 and 13), and the other is to choose the stage pressures so that the upload is reduced and the down load increased. Increased down loads necessitate larger connecting rod bolts, which in some cases, on account of the restricted space available, might not be easily accommodated.

Provision for Variable Delivery Pressures and Volumes

Another consideration when fixing stage proportions is the possibility of the machine being run at delivery pressures higher than normal.

In the remarks on clearance this question was mentioned, and the advantages of large clearances in this connection were enumerated.

The loads to which large clearances give rise (Figs. 12 and 13) might be inadmissible for various reasons, whilst the increased cost due to the larger cylinders might be a disadvantage, so that the constant proportional division of work between the stages, almost always approximately possible of attainment by choosing suitable clearances, would not in this case be secured.

If the machine runs at a pressure above its normal the division of work will be upset, and the high-pressure stage will take a considerably increased share of the total load, which may result, among other things, in an undue rise of final delivery temperature. If this latter is reasonably low when the machine is working at normal pressure, the rise due to the increased pressure will not be of such great consequence. To meet these conditions it is usual to arrange that the high-pressure stage shall, under normal conditions, take rather less than its proper share of the total work. The temperature in the other stages will be somewhat increased, but the rise in these temperatures due to the small increase in pressures as a result of the greater delivery pressure is inconsiderable.

If the machine has to run throttled in order to reduce the volume delivered, then it is again desirable, if possible, to arrange that the high-pressure stage shall under normal conditions take the smallest share of the work, since throttling reduces the stage pressures without altering the delivery pressure, thereby resulting in an increased high-pressure delivery temperature.

The importance of keeping the high-pressure temperatures low may again be emphasized. Burning and explosion of the lubricating oil here is of great violence when it does occur, which happily is very rare, due, among other things, to the attention given to the selection of the oil itself.

Volumetric Efficiency

One other point which arises in connection with the determination of stage proportions is the question of the volumetric efficiency of the low-pressure cylinder. If the low pressure stage is given a large share of the work, the effective capacity of the machine will be less than it would be with a lower first stage delivery pressure for reasons explained in the notes on the effect of clearance.

From the above it will be seen that multistage compressor design is to a large extent a matter of compromise. Each case should be treated by itself according to the duty of the machine and conditions under which it is to be run, and the best combination under the circumstances of loads, balance, and temperatures should be found, whilst the behaviour when throttler or running at various pressures must also be considered.

The question of cost should not be forgotten, for in some cases the advantages gained by, say, adding clearance, and thereby increasing cylinder sizes, may not warrant the additional expenditure.

Cylinder Proportions

Fig. 18 shows the stage pressures adopted in some of the very latest three-stage compressors for Diesel engines, by four different British and Continental builders, and bears out the remarks regarding the compromise in design of compressor.

Having decided on the stage pressures and cylinder clearance ratios, the actual determination of main dimensions is relatively simple.

When fixing the cylinder sizes, the low-pressure cylinder is settled first, as in a steam engine. A low-pressure delivery pressure is assumed—basing the assumption on previous practice if available—and from this pressure and the clearance volume in the cylinder (depending largely upon the type of valves used) the indicated volumetric efficiency is calculated. The dimensions of the cylinder are chosen such that, after the clearance air has re-expanded, the cylinder can draw in the required amount of air, plus an allowance for leakage through the compressor. Regard should also be paid to the fact that the air on its way to the cylinder, through contact with hot valves, passages, etc., becomes heated—which reduces the actual weight of air dealt with.

Where the workmanship is of the first order, about 85 to 90 per cent. of the air actually taken into the compressor will be delivered when compressing to 1,000 lb. per square inch in three stages.

The second stage cylinder is proportioned so that after its clearance air has expanded it can contain the whole of the air delivered by the low pressure at the low-pressure delivery pressure, and at the temperature resultant upon the mixing of the incoming and the clearance air. Attention should again be given to the effect of the hot cylinder cover, piston,

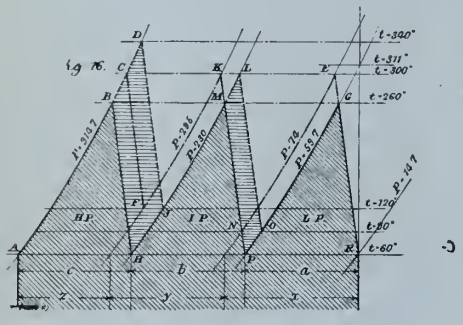


FIG. 16.

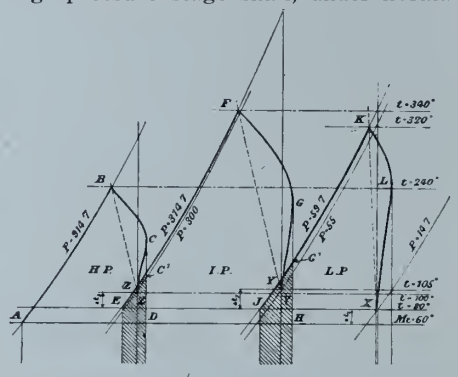


FIG. 18.

This chart may also be used to determine the ideal stage pressure (i.e. equal compressions per stage for compression to pressures up to 1,000 lbs. per sq. inch in 2 or 3 stages. For 3 stages of compression a line from the zero point to the intersection of the delivery pressure line and vertical H.P. cuts the other verticals in the ideal pressures. Example:—3-stage compression to 500 lbs. per sq. inch gives—L.P. pressure = 33 lbs. per sq. inch, and I.P. pressure = 142 lbs. per sq. inch gauge. For 2-stage compression join zero point to intersection of delivery pressure line and vertical I.P. The L.P. pressure can then be read off as before.

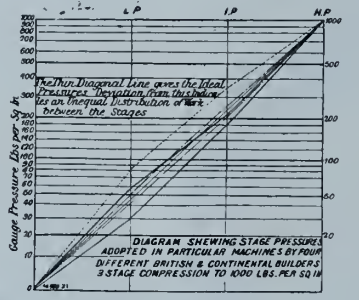

L.P.
I.P.
H.P.
The Thin Diagonal Line gives the Ideal Pressures. Deviation from this Indicates an Unequal Distribution of Work between the Stages
Gauge Pressure Lbs per Sq. In.
DIAGRAM SHEWING STAGE PRESSURES ADOPTED IN PARTICULAR MACHINES BY FOUR DIFFERENT BRITISH & CONTINENTAL BUILDERS 3 STAGE COMPRESSION TO 1000 LBS. PER SQ IN

FIG. 17.

etc. The other stages are similarly treated.

Experience is an important factor in the settling of cylinder proportions, as in the higher stages, at any rate, it is essential that allowance be made for leakage. For example, in a four-stage machine compressing to 3,500 lb. per square inch, possibly not more than 80 per cent. of the air taken in ever reaches the high-pressure cylinder. If this cylinder is made big enough to deal with the whole of the air aspired by the machine, it would actually take considerably more than its intended share of the load.

One method of finding the volumes of the various cylinders is the "constant weight" method, which depends on the fact that (neglecting leakage) the weight of air in all the cylinders at the end of the suction stroke is the same, correction for leakage being made afterwards. Another method, which can be used graphically, is the "equivalent cylinder" method. Here the volumes of the ideal cylinders with no clearance are found, assuming the compression isothermal, and an adjustment is then made for the effect of clearance air and temperature rises.

When the cylinder sizes have been determined, the size, location and number of valves may be fixed, determining to a great extent the way in which the necessary clearance volume is made up.

Small deviations are often made from the theoretical figures for reasons of manufacture. Supposing that the calculated high-pressure cylinder diameter was 3⅜ in., for convenience of manufacture this dimension might possibly be made the more even figure of 3½ in., entailing, however, an increase of 7½ per cent. in the volume. Some builders, however, work to sixteenths of an inch in cylinder diameters.

Modern Multi-Stage Compressor Practice

Comparison with Steam Engines.—The care and consideration which must be given to the question of proportioning a compressor is probably of more importance then that required for, say, steam engine design, in addition to which the engineering practice for the successful construction of compressors must be of the highest order. In the case of a triple marine engine, the cylinder clearance volumes are of comparatively small importance, and the arrangement of the engine need not be altered to suit the clearances. Should the distribution of work be less even than as designed, it is only necessary to alter the cut-off in the different cylinders. The work done by the high-pressure cylinder can readily be reduced by cutting off earlier in the medium-pressure cylinder, but in an air compressor reduction of the high-pressure work entails the addition of clearance volume to the high-pressure cylinder, which addition it is usually almost impossible to effect.

Small errors in the calculation of steam engine design have sometimes been corrected by the introduction of packing pieces, or stepped keys in the valve gear, but with a compressor it is rarely possible to correct mistakes. The workmanship must be of the highest class, especially with such details as valves and high-pressure plungers. Piston rings and cylinder bores also call for particular attention.

A noteworthy difference between steam engine and compressor design is that, whereas with the great majority of steam engines the cylinders are double-acting, in high-pressure compressor work they are invariably single-acting in the generally accepted sense of the term. Another difference is the very frequent use of differential pistons, which are rarely met with in steam engines. These points give rise to a large number of possible arrangements of compressor cylinders, a few of which are shown diagrammatically in Figs. 19 to 29.

Cylinder Arrangements — Fig. 19 shows the most common arrangement of a three-stage compressor. On the down stroke air is drawn into the space marked low pressure through the suction valve, having previously passed through a silencer. On the up stroke this air is compressed, and delivered through the first stage intercooler to the annular space marked intermediate pressure, where, on the next down stroke, the second stage of compression is effected. The air is again cooled in an intercooler before passing to the high-pressure cylinder, where the final compression is carried out. Before the air is delivered to the storage bottles it is customary to pass it through an aftercooler (consisting usually of a submerged pipe), in order that the air in bottles shall not become unduly heated. This compressor arrangement is largely adopted on Diesel engines, as well as for independent plants on account of its comparative simplicity and compactness, but it has several disadvantages.

To examine or renew new-pressure or intermediate-pressure piston rings, it is generally necessary to lift the whole piston and connecting rod up through the cylinders before the gudgeon pin can be removed, which in some cases, such as in submarine engines, is an undesirable feature on account of the limited head-room usually available. It may also be noted that the low-pressure and intermediate-pressure work is all done in the same cylinder, as it were, so that more heat has to pass through the cylinder walls to the jacket than would be the case were an

FIG. 19.

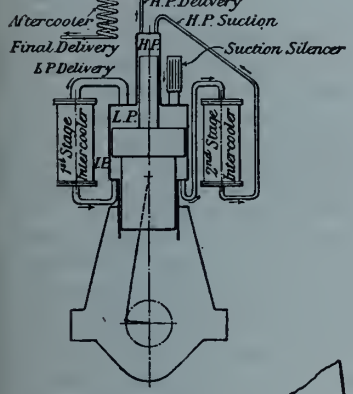


FIG. 20.

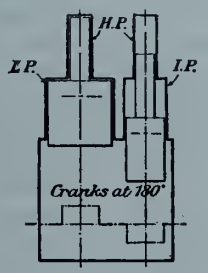


FIG. 21.

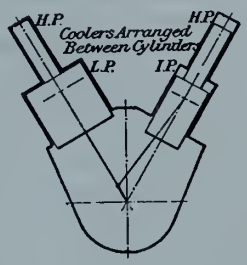


FIG. 22.

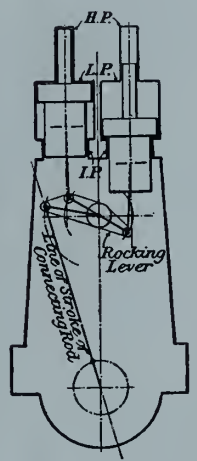


FIG. 23.

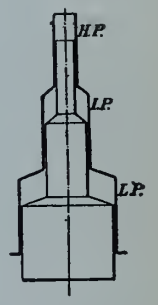


FIG. 24.

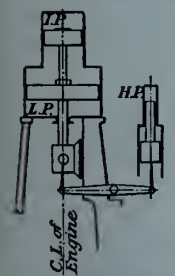


FIG. 25.

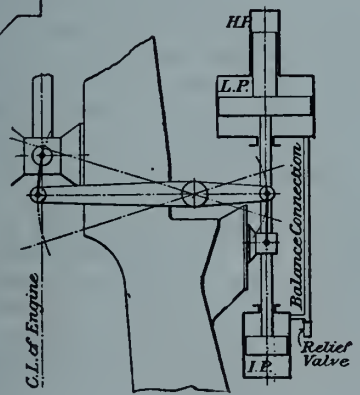


FIG. 26.

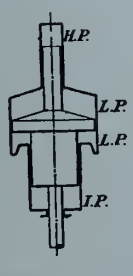


FIG. 27.

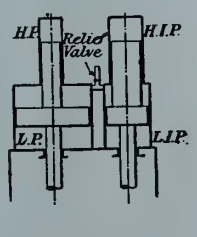


FIG. 28.

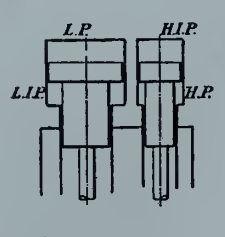
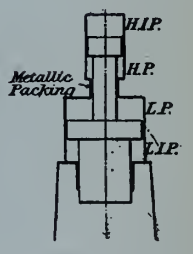


FIG. 29.



entirely separate cylinder devoted to each stage of compression. This, however, in practice is not of much moment.

Fig. 20 shows a small two-crank machine suitable for a motor-driven plant. With this type of machine the working parts are in constant thrust. A modification of this last arrangement is shown in Fig. 21, where both lines are driven by the same crank. This "V" compressor has been used on several marine Diesel engines, where the effect of the uneven turning moment resulting from this design is of but slight importance. It may be added that the angle of the "V" is usually somewhat less than that shown diagrammatically in the figure.

A curious adaptation of the type shown in Fig. 19 is given in Fig. 22. This arrangement, although expensive, has been used on some of the largest high-speed Diesel engines yet constructed, and is very satisfactory in operation. Instead of employing a single compressor, two entirely separate small machines are used, actuated from the ends of a rocking lever driven from the crank shaft by means of a single connecting rod.

A great advantage gained is a reduction in the size of cylinders necessary, which results in a marked improvement in the cooling and reliability. In addition, the turning moment of the combination is good, whilst the side thrust on the pistons resulting from the obliquity of the connecting rod in the usual design is, in this case, almost entirely absent.. Another minor point to which attention may be directed is, that if a compressor valve breaks on, say, the starboard engine in a ship with this arrangement, only 25 per cent. of the main engine air supply is stopped, instead of half, as would be the case were each main engine fitted with a single compressor. As a result, it is quite likely that it would be found possible to carry on without running a big auxiliary compressor, which in many cases, being motor driven, entails the operation of a large generator set. Fig. 23 shows the arrangement occasionally adopted for Diesel engine work. Its obvious feature is its simplicity.

An arrangement which has been employed in one or two instances is shown diagrammatically in Fig. 24. Here the high-pressure stage is entirely separate from the other cylinders, and is driven by means of rocking levers. Accessibility is a feature of this design. To remove the intermediate-pressure piston it is only necessary to lift the intermediate-pressure cylinder cover and take off the nut securing the piston to the rod. By lifting the intermediate-pressure cylinder a little, it will now be a simple matter to withdraw the low-pressure piston. The high-pressure piston is easily withdrawn by putting the crank on top centre and uncoupling the link between the levers and piston. Note that the first stage of compression is effected on the under side of the low-pressure piston. This means that the heat from the intermediate pressure is well removed from the heat of the low pressure, so that the cooling is more efficient. The air in the space between the low-pressure and intermediate-pressure pistons is simply compressed on the up stroke, and re-expands on the down stroke—a relief valve being provided to guard against excessive pressurt due to piston ring leakage.

Fig. 25 gives another arrangement of compressor suitable for a Diesel engine, where the air displaced by the idle side of the low-pressure piston is passed to the idle side of the intermediate-pressure piston in a similar manner to the previous case.

In the arrangement shown in Fig. 26 each side of the large piston does a part of the first stage of compression, whilst the second stage is effected in a cylinder at the bottom, as shown. This necessitates the use of a gland subjected to a pressure of perhaps 300 lbs. per square inch as well as a high temperature, but this is of minor importance. The up and down loads are more nearly equal than is the case with the usual arrangement, and, in addition, the maximum crosshead load for a given capacity is reduced as a result of the decreased low-pressure piston diameter. It may be mentioned that this arrangement is adopted in one of the largest compressors yet built for Deisel engine work.

Figs. 27 and 28 show arrangements of four-stage compressors, suitable for torpedo air compressors. The former design necessitates glands, but permits of rather better cooling than the latter, which, however, has an advantage in that crossheads may be dispensed with if required.

A single-line four-stage arrangement is shown in Fig. 29, but this suffers somewhat from lack of accessibility, although the loads up and down can be equalized, as two stages of compression are carried out on each stroke. There are other arrangements to suit various conditions as to accessibility, compactness, balance, etc.

Cylinders and Piston Packing

The conditions under which compressor pistons run are different from those in a steam cylinder, where there is generally a certain amount of condensation and the water so formed acts as packing in an effective manner. In a compressor a little moisture from the atmosphere is present, but this is generally insufficient to permit of using, for instance, solid piston valves, as sometimes met with in steam practice. Special attention should be given to the question of piston packing, which, however perfect, is useless unless the cylinder bore is machined to within extremely fine limits, the required accuracy being greater the higher the pressure which has to be withstood. In the case of high-pressure cylinders opinion is divided as to the best means of producing the nearest approximation to the perfect bore. Some builders finish the bore by an elaborate system of reamers, and the accuracy and uniformity of the bore so produced leave little to be desired. Other manufacturers pin their faith to grinding methods, and in many cases the bore is lapped out to size. The packing used on high-pressure pistons is varied. For machines such as those used for torpedo charging, which only run intermittently, leather or some patent packing of a similar nature is used. Any slight unevenness in the bore or lack of alignment is taken up easily, and the leakage is very small. The question of temperature should not be overlooked, for if these are too high, burning of the packing will result, and in some cases, to reduce the possibility of this as far as possible, cylinder lubrication is effected by means of a comparatively copious supply of soap-water, oil being used but sparingly.

In compressors for pressures above 2,500 lbs. per square inch it is almost universal to find leather or similar high-pressure packing, and very frequently arrangements are made for introducing a certain amount of distilled water with the suction air. There are two ways of fixing the packing, one of which is to carry it on the piston, in the same way as piston rings, and the other is to use it in a similar method to that usually adopted with hydraulic machinery — the particular method adopted depending on the arrangement of the compressor.

For a Diesel engine compressor, or any machine which has to run at full load for long periods at a time, leather is not sufficiently durable, and recourse is made to metallic packing, consisting generally of piston rings. These rings are usually made of selected cast iron, and may be of the ordinary "Ramsbottom" or other types. Some builders adopt rather elaborate packing systems for high-pressure pistons which have special properties, such as being adjustable for axial wear and being self-aligning, whilst others use plain cast-iron rings with almost equally good results.

One point in this connection which may be mentioned is that "air packing" should never be adopted with high-pressure pistons, since the high-pressure air forces out the ring against the cylinder wall, and whilst giving a splendid result as far as air-tightness is concerned, increases the wear of the cylinder. Occasionally metallic packing is used in a type of gland, with, in some cases, satisfactory results. The packing may be of the manufactured ring form, or may be shredded white metal and graphite.

Regarding the other cylinders of the compressor, equal attention should be paid to the bores as with the high-pressure cylinder. The piston packing adopted consists usually of cast-iron rings, although some manufacturers fit leather or similar packing throughout the machine. For glands under air pressure, metallic packing is preferable, as the majority of the usual packings quickly deteriorate under the dry heat to which they are subjected.

Valves

The question of the design of valves for an air compressor is one which demands careful thought and attention, for no other part is so vital to the proper working of the machine. The type of valve used in all high-pressure compressors is the automatic valve, which depends for its action on a difference of pressure above and below it, and is not actuated by any external means. This appears in countless forms, but of few can it be said that they are entirely satisfactory.

Automatic valves are essentially of a more or less delicate construction, and the conditions under which they operate are usually severe. The delivery valves have to pass air at very high temperatures, and the heat, unlike that in a steam engine, is a dry heat; whilst in a high-speed machine running at, say, 450 r.p.m., the valves have to lift and seat themselves in a very short space of time.

For example, in a low-pressure cylinder in which compression is carried to 80 lb. per square inch gauge, at 450 r.p.m. the delivery valves have to open, pass the air, and completely seat themselves again in a period which is actually less than one-sixtieth part of a second. In order that this operation shall be successfully accomplished, either a powerful spring must be used to reseat the valve, or else the lift must be exceedingly small. The result of using a strong spring is that the pressure required to open the valve is excessive, and the hammering of the valve on its seat under the influence of the spring results in very rapid wear. The alternative, namely, the adoption of a small lift, means that the diameter of the seat must be large in order to obtain the requisite area through the valve for the flow of air. It may be stated that velocities in practice through the valve may be 130 ft. per second for low-pressure valves, and may be 250 ft. per second for high-pressure valves. If the diameter of the seat is increased over that sufficient with a larger lift, the leakage is increased, owing to the larger circumference of the contact circle; and, moreover, since a large valve is more liable to heat distortion than a small one, the possibilities of leakage are still greater.

Whatever the diameter of the valve, the weight should in every case be brought to the minimum. This reduces the inertia forces, and thereby the spring strength. Consequently the wear due to hammering and excess pressure required to open the valve is decreased. The type of valve usually employed for high-pressure work is the thimble valve, which can be used either for suction or delivery, two or more being used per cylinder to obtain the necessary area of flow. The valves proper are usually of nickel steel, and the seats of best quality bronze or gun-metal, although one Diesel engine builder used to fit valves in small compressors with seats of ebony or lignum vitæ. The actual seat should be as narrow as possible, in order that the unbalanced load may be reduced to a minimum.

For moderately high pressures small valves of the well-known plate type are frequently used. The plate is usually of special steel and the seat of bronze. It has been found in practice that this type of valve, at any rate in the larger sizes, is liable to fracture if the lift is too great, so that, in order to obtain sufficient area for the passage of the air and at the same time keep down the diameter, it is necessary to adopt multiple seats and to cut ports in the valve for the exit of a part of the air. Given suitable conditions, this type of valve when properly designed and made is superior to the thimble or poppet type, especially for the low-pressure stage, but the plates are somewhat unreliable when the temperature is excessive. One advantage over the other type is that carbonisation has very little effect on the working.

A type of valve to which one prominent Continental firm have pinned their faith is the "Gutermuth" valve, which consists essentially of a strip of steel wrapped round a spindle in a similar manner to a clock spring. This has been used with great success in all the stages of Diesel engine compressors up to quite large sizes.

In high-pressure compressor work the valves must be kept in thoroughly good condition, as otherwise a leakage may take place from any stage to a lower one, thus increasing the pressure and temperature attained in the latter. This would upset the balance, and in extreme cases cause a serious breakdown by adding, perhaps, 250 per cent. to the load on the connecting rod bolts. To guard against such contingencies it is of the utmost importance that ample relief valves be fitted to all stages, and however reliable a machine may appear to be, it is dangerous to run with the relief valves out of action.

It is not proposed to deal with mechanically moved valves, as their application to high-pressure compressor work is limited, usually to the low-pressure suction, with perhaps the addition of the intermediate-pressure suction. The great advantage of a mechanical suction valve for the low pressure is that one can ensure that the cylinder is filled with air at atmospheric pressure, instead of at a lower pressure due to the attenuation consequent upon a spring-loaded suction valve. If this mechanical valve is arranged in the piston itself, as is done in some designs, the cylinder clearance volume can be appreciably reduced. The delivery valves are invariably automatic. A valve gear which would adapt itself to the varying point of delivery with different pressures would obviously be somewhat complex. In high pressure work the necessity for this refinement is rather doubtful.

Regarding the disposition of valves, these are usually arranged in the cover of low-pressure cylinders in order to reduce clearance as far as possible, thereby seriously detracting from the cooling surface. Suction valves in the piston are not without disadvantages, since at the end of the suction stroke the inertia of the valve tends to seat it too soon and the cylinder is not fully filled with air. In some cases this arrangement necessitates the suction air being drawn through the crank case. It is argued that this tends to keep the running parts cool, but this is a doubtful advantage when it is remembered that the low-pressure compression starts with air which has been already heated, and is probably charged with oil vapor.

COOLING POWER OF A REFRIGERATING MACHINE

THE cooling power of a refrigerating machine is based and calculated on a continuous run of 24 hours per day. If, therefore, a machine is specified of 24 tons cooling capacity, it will have to run continuously for 24 hours to accomplish this amount of work. During one hour's operation, the machine will only give a cooling effect of one ton. If a certain amount of work is required to be done in 12 hours the capacity of the machine must be double that required to do the work in 24 hours.

All refrigerating machines are rated or specified of so many tons cooling capacity or, in other words, are equal to so many tons of ice melting. As a ton of ice when melting gives off 284,000 B.t.u. at a temperature of 32 degs. Fah., a refrigerating capacity of one ton is, therefore, equal to 284,000 B.t.u. with a brine temperature of 32 degs. Fah. By B.t.u., or British thermal unit, is meant the power to cool one pound of water one degree, or what is the same, 1-10 of a pound. 10 degrees.

The refrigerating capacity of a compressor depends on the weight of the ammonia gas circulated per 24 hours. As the weight of the ammonia gas as well as the temperature depends on the pressure, that it to say, as the weight and temperature of the gas rises or falls with the pressure, it follows that the higher the refrigerating temperature the greater will be the work that the compressor will accomplish, and the lower the refrigerating temperature, the less work the compressor can do. This is the reason that in cold stores the amount of compressor power required to keep temperatures of zero in the rooms is more than double that required to keep the temperature at, say 30 degs. Fah.

CONCERNING BELTS

EXPERIENCE has shown that a long belt, other things being equal, will transmit more power and last longer than a short one. It is easy to remember that a belt one inch wide, travelling 800 feet per minute, and with suitable tension, will transmit one horse-power. If the same belt travels 1600 feet per minute, or if the 800 feet belt is 2 inches wide, both will transmit two horse-power, and so, for every extra inch of width, or an additional speed of 800 feet per minute, an extra horse-power will be procured. If a belt is laced too tightly there will be no fault in its driving, but the journals of the shafts that carry the pulleys will have too much to do, and will soon wear out. If a belt is laced too much on the slack side-slipping will take place, and extensive friction on large cast pulleys has been known to generate sufficient heat to crack the pulleys, even to cause them to burst and fly about and kill. A horizontal belt of considerable length and laced only just tight enough is an ideal drive. Between this ideal drive to the worst, i.e., a vertical drive with a short belt, there are many gradations, but so long as one always visualises the ideal and the worst, care will always be taken when arranging drives to approach the former and ignore the latter.

Electricity and Hydraulics

BRUSHES FOR COMMUTATORS AND SLID RINGS*

IN the selection of brushes for commutators and slip rings there are several important governing factors. Among those of ranking importance are the following:—

1—The brush should possess such characteristics as will enable it to carry the maximum current to be transmitted by it. This maximum current consists of two factors for either direct-current or alternating-current use, viz.:—

(a)—The kilowatt load or working current of the machine, whether direct or alternating.

(b)—The short-circuiting current between the bars being commutated in direct-current service, and the magnetizing currents due to power factors above or below unity in alternating current service.

The kilowatt load or working current is readily measured or determined in terms of either direct current or alternating current and for alternating-current service the magnetizing, wattless or idle currents can also be definitely measured or calculated. The short-circuiting current under the brush, however, is a very indefinite factor and may have values ranging from approximately zero in a machine having ideal commutating characteristics to values in excess of the load or metered current in machines having poor commutating characteristics. Brushes, therefore, may be, and generally are, subjected to loads greatly in excess of the load, or kilowatt, current.

Anent the short-circuiting current under the brush:—A direct-current, non-commutating pole generator was designed for, and sold with, a given rating, the rating being in excess of the immediate demands. As the demands increased, armature temperatures became abnormal and commutating troubles expanded. It was impossible to commutate within many kilowatts of the name-plate rating. A local concern proposed to make the machine deliver its full-load rating for a given sum, with the further understanding that a bonus of so much per kilowatt was to be paid for each kilowatt output in excess of the machine's one hundred per cent. rated capacity. In the event of failure no money was to be paid. The proposition being accepted, several modifications were resorted to, the principal one being that of "trimming" or "beveling" the poles. In time the machine was groomed for the bonus; the test followed—also a failure. The machine not only failed to deliver its full-load rating, but persisted in dangerous temperatures. A friendly engineer was consulted, who with a flight of surprising intelligence for a man of his profession, suggested that the brushes be slotted, parallel with the commutator bars, and to a depth of an inch or more. The output jumped; temperatures dropped; the repair concern collected its bill, plus a bonus, and the friendly engineer stood modestly by, with satisfaction for his portion. This is not a fanciful sketch, but a fact, and illustrates the unknown which is taking place to a greater or less degree under all commutating brushes.

2—The brush should be homogeneous, i.e., it should be uniform in material, mixture and hardness (free from hard and soft spots.)

3—Brushes for either alternating or direct-current use should be self-lubricating. Experience shows, however, that the vast majority of brushes require lubrication. In many instances brushes are "treated" by the makers, i.e., they are impregnated with certain lubricating oils, greases, or compounds, in order to make them self-lubricating, or as nearly self-lubricating as possible. Generally speaking, the permanency of such treatment is problematical, inasmuch as the lubrication frequently volatilizes , or drains from the brushes, leaving the brush practically, if not entirely, in its dry state.

4—For undercut commutators the brush material should be entirely, or to a great degree, free of abrasive (that is, of certain cutting compounds or mixings which are added to the brush material to scour or polish), or the commutator will wear too fast, bridge the slots. necessitate frequent beveling of the bars, repeated undercutting and constant cleaning.

5—For smooth commutators with soft mica a larger percentage of abrasive is desirable than in brushes for undercut mica.

6—For smooth commutators with hard mica brushes should be highly abrasive. This usually means a decreased brush capacity and decreased lubricating values, although it is claimed for some brushes that proper abrasive effect is secured by hardening under enormous pressures, no abrasives being used.

7—For alternating current or slip rings the brushes should be as nearly self-lubricating as possible and should wear themselves rather than wear or cut the rings. These brushes may be of metal graphite composition or of a graphitic nature only. If of metal graphite they should not wear so as to form a continuous "fringe" or "wire edge" along the sides of the brushes at the rings, but should be of a mixture sufficiently granular to disintegrate and break away in small particles. The "fringe" or "wire edge" has been known to form and break away from the brush in full brush contact lengths, falling so as to bridge to adjacent rings and cause disastrous flash-overs.

After selection, the success or failure of a brush may be directly due to its application. This may be traceable to the following causes:—

1—The angle at which the brush is set. It is true that certain types of machines which are subject to frequent reversals, such as mill motors and street railway motors, may be said to automatically fix the brush position as radial, or practically radial. In the case of railway motors this is perhaps the universal practice. This does not mean, however, that if set at some angle, say 15 or 20 degrees, or even a greater angle, the average results might not be as good, if not better, than the radial setting. When machines are not subject to reversals, the proper angle will depend,—

(a)—Upon whether the rotation is against the toe or against the heel. (By "toe" is meant the point of the brush, or the side having the acute or small angle. The "heel" is, therefore, the side having the larger angle. This is independent of rotation.) If against the toe, the angle may be as great as 35 degrees or more, but above 35 degrees the toe becomes very sharp and mechanically weak. This point, therefore, must be guarded against. If against the heel, the angle may be from 12 degrees to 25 degrees. In instances where the brush touches more bars than required the sharp toes can be beveled off, thereby reducing the brush contact and the short-circuiting current under the brush, and at the same time increasing the mechanical strength of the brush. Whether running against toe or heel it is good practice to round off the sharp or knife edge of the toe. This reduces the possibility of the knife-like edges digging into the commutator in case the brushes jam or become tight in their holders, and at the same time protects against brush breakage.

(b)—Upon the friction coefficient of the brush. This factor is a decidedly variable one, being influenced not only by the inherent characteristics of the

*The Electric Journal.

brush, but also by the glazing of the contact face of the brush, the varying brush temperatures due to load and spring pressure, and the condition of the commutator—whether smooth or undercut, hot or cold, or in good, poor or bad mechanical condition. As a rule, bad mechanical conditions can be eliminated by properly seasoning the commutators and keeping them practically round, smooth and free from high mica. The other influences, however, are permanent, although they may be, in a measure, modified by finding a more suitable brush angle.

Brushholders

2—Brushholders vary widely in design. There is no universal holder. If the commutator or slip ring speed is low, a holder having a sluggish spring and slow action will give entirely satisfactory results; such a holder on a high-speed machine may fail miserably. High speeds require quickness of action on the part of the brush. This means a sensitive quick-acting spring and a holder designed to aid the spring. A high-speed holder may give excellent results on low-speed machines; but a low-speed holder is not likely to approach even fair results on high-speed machines. Brushholders should be designed to meet specified conditions, not merely designed to cheapen manufacture. Money is intelligently and economically invested when invested in well-designed, capable holders, but utterly wasted when "soaked" in flimsy substitutes. Much depends upon the type of brushholder. Certain fundamental requirements are often too indifferently regarded. Brushholders must be stable, and should be built on lines conforming closely to the lines of the brush as it will appear when in service.

The box, or part holding the brush, should be as nearly a full box as possible. To accomplish this, the shunt attachment (and brush-lifting clips when used) must be flush with the face of the brush, and the pressure spring so designed as to give maximum brush wear without necessitating too great slotting or cutting away of the holder on the sides. Whether the rotation is against the toe or against the heel, both the toe and heel sides of the holders should have approximately equal areas for the support of the brushes. It is obvious that the shorter the box, the greater will be the shifting movement of the brush on the commutator due to looseness in the holder; and the deeper the box, the less will be the shifting. From this it follows that the boxes should not be too short, nor should the brushes be too loose in the boxes.

It is an established fact that with even very slight play in the holder the changing brush friction due to load, temperatures, etc., will result in a changing relation between the brush and the commutator, and thereby cause changing and misleading brush drops from day to day. This accounts for the difficulty in verifying, on different days, brush drops, although the loads may be identical. The neutral does not change, but the relation of brush contact to commutator does change, and the brush drops vary accordingly.

Another explanation for the changes which take place in brush drops is that when brushes have been freshly "sandpapered" or "ground in" the surfaces have unglazed or soft faces, the brush drops being influenced by the porous condition of the faces, and the lubricating values of the particles liberated during the time the brush face is seating itself to the commutator. During this period the commutation, with certain kinds of graphitized brushes, may be much better than after the glaze or permanent surface forms on the brush. Drops taken during this time may not be the same as drops taken after the brush is "faced up" and may prove seriously misleading. Definite or reasonably permanent drop valves are, as a rule, to be had only after the brush faces have reached a fixed condition.

From the foregoing it it obvious that brushes should fit snugly, but not tightly, in the holders; also that there are certain relative dimensions which are preferable between the brushes and holders, and which must not be ignored if the best results are to be obtained. For instance, the side of the holder in the direction of rotation should not have less area than the lagging side. In fact, the side against which the brush presses should have preferably a greater area than the opposite side—certainly not less area. With a limited area to oppose the brush, movement of the brush in the holder, due to looseness, oscillation and imperfect relations between the brush and commutator, accentuates the change in the angle of contact, and results in poor commutation, as well as in mechanical and electrical damage to that part of the brush in contact with the holder.

SEWAGE PURIFICATION BY ELECTRICITY

By C. T.

THE uses of electrical energy are so vast that it is little wonder that attention is now being paid to its employment for sewage purification. A process has recently been invented by which crude sewage is passed through a trough, partially fitted with electrodes placed at right angles to the line of flow and connected in parallel with a current of low voltage. The system is based on the theory that sewage containing table salt and other electro is rapidly decomposed by the passage of the current and that caustic soda, nascent chlorine, hydrogen and oxygen are thus evolved. Part of the freed chloride combines with the soda, lime and iron thrown off by the electrodes, and hypochlorites are thus formed, which attack and break up the organic matter. Experimental plants on this system have been provided in several small communities with varying success. Another method has been tried in the borough of Queen, New York, and at the stockyards in Chicago. This system differs from the former by the provision of a paddle between each electrode, the rapid motion thus engendered keeping the sewage constantly agitated and the face of the electrode well secured. To obtain the requisite standard of purification, quantities of lime are added, and engineers are by no means in perfect agreement as to whether it is the lime or the electrolysis which performs the more efficient work of purification. The cost of working this system is unattractive, but it is interesting to learn that steps are being taken to harness electricity for the purpose of sewage disposal, as the subject is one of increasing importance and has not yet been perfectly solved.

Shawinigan Falls, Que.—The Shawinigan Water & Power Co. is preparing designs for a 5000 ft. clear conductor span for the transmission of electric energy over the St. Lawrence River at Three Rivers, Que., which will supplement the submarine cable transmission line already installed. Each of the steel towers on which the line will rest at the extreme ends of this long span will have a concrete base, set some little distance from the bank of the river. The towers will be 350 ft. high, so as to provide a clearance of 160 ft. in the centre of the span. The three conductors will be placed approximately 50 ft. apart. The transmission line will not be anchored to but merely supported by the towers and anchored to concrete blocks situated some distance to the rear of the towers.

Hydro May Expropriate Power.—Within a month or so the Ontario Hydro-Electric Commission will take steps to expropriate the power which is being exported by the Canadian Niagara Co. and the Electrical Development Co., if the developing companies refuse to supply the Hydro Commission with the amount of power they require. By this means 83,000 h.p. will be available to make up the shortage of power in the province. The Electrical Development Co. is exporting 50,000 of its horsepower, and the Canadian Niagara Co. is exporting 30,000 horsepower. The old Ontario Power Co., which the Hydro Commission purchased and took over a month ago, was exporting something like 40,000 horsepower. Now there is said to be 83,000 horsepower wanted by the Hydro Commission to make up the shortage of power, and this will have to be supplied by the two first companies.

Montreal, Que.—In a report signed by Messrs. H. E. Vautelet and A. St. Laurent, consulting enginers, the Board of Control is advised that the city proceed with the hydraulic development of the aqueduct along the lines suggested by them in Scheme 2 of their original report; they also recommend that the foundation of the power house be built as early as possible to insure the water supply of the city, while it is also suggested that the balance of the work be proceeded with along the lines recommended by them as circumstances will allow.

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Vol. X. SEPTEMBER, 1917 No. 9

PRINCIPAL CONTENTS

Power Equipment Installation for Candy Manufacture.....251-252
General 252
Gasket Memoranda....Rope Capacity of a Drum.
Engineering Exhibits at the Canadian National Exhibition.....253-256
Preparing Heating Boilers for Service.....256-257
General 257
Graphite Remedy for Boiler Scale....Observations on Rope Drive Practice.
Brief Historical Sketch of Steam Boiler Making in Canada.....258-259
High Pressure Air Compressor Design and Application.....260-265
General 265
Cooling Power of a Refrigerating Machine....Concerning Belts.
Electricity and Hydraulics 266-267
Brushes for Commutators and Slip Rings....Sewage Purification by Electricity....Hydro May Expropriate Power.
Editorial 268
Skilled Mechanics a Post-War Necessity.
Association and Personal 269
Water Gauge Packing Hints 269
The Operators' Point of View 270-272
What Happens to Technical Magazines....Gravity vs. Forced Feed Lubrication....A Wire Hanger Rack....Simple and Effective Flywheel Guard....Kerosene as a Motor Fuel ....Does a Piston Stop at Reversal?....Steel Chimney Troubles....Temporary Repairs to Gas Engine Governor.
Operators' Instruction Course 273
Education Paper—III.
Steam Power Plant Auxiliaries 274-275
Pressure Reducing Valves—I.
Selected Market Quotations 276
Projects and Developments (Advtg. Section) 46-48

SKILLED MECHANICS A POST-WAR NECESSITY

THERE is a growing disposition to recognize that the peace-time essential of this or any other manufacturing country will be its muster of skilled mechanics. Shell-making has not, as is perhaps too generally believed, contributed materially to Canada's pre-war quota of the latter for, with the exception of a fair percentage increase, comparatively, in the ranks of her tool-makers and equipment designers, the abnormal activity of the past thirty months has done little more than demonstrate the possibility of rapidly training as attendants men who to all intents and purposes were in the rough so far as machine tool operating knowledge was concerned.

Shell manufacture was highly specialized, but in the nature of things was quite temporary in character. Urgency of production by the most direct means available was the keynote of the whole enterprise, as a consequence little opportunity was afforded for a widespread development in the training of expert mechanics, men who in the coming time would give our metal-working industries the degree of backbone and vigor which will undoubtedly be required if we are to procure and maintain a foothold in the world's markets. With the cessation of shell-making, attention is naturally being focussed on lines of product that will provide capacity activity for our now enlarged plant establishment, while giving at the same time assurance of there being retained in steady and continuous employment the skilled men now possessed, as well as providing opportunity for materially supplementing their numbers.

It should be borne in mind that, despite the war activities now so pronounced in the United States, and those no less in evidence in Great Britain and elsewhere, the keenest interest is being displayed in the matter of post-war trade preparedness, and that recognition as never before is being taken of the thoroughly trained and expert mechanic as the principal factor in the conditions with which we will be confronted. As an indication of how the subject is viewed in the Old Country, the following paragraphs culled from a recent editorial in our contemporary, *Engineering*, may not be without interest to our metal-working plant executives:

The deficient supply of skilled men is acutely realized and is exercising the minds of all who employ mechanics.

A man having the mentality, dexterity and character taken for granted or implied in the term skilled mechanic, or competent all-round craftsman, is prima facie a competent individual in a much wider manner than in a purely trade sense.

Natural aptitude, large mentality, resource, initiative, grit, character—all matters which make a man worthy of respect—are the inalienable possession of the man who becomes an expert mechanic.

Good mechanics were never plentiful, but present-day conditions have separated all men into two classes, those having skill and those without. Consequently, there has been a remarkable appreciation in value, the intrinsic worth of real skill has never been so realized as now. It is contended that, unless steps are taken to enable men to acquire real skill, invention will be paralyzed, improvement will be forfeited, and business some time or other will have to be rebuilt upon its old foundations.

How can we have mechanics unless we deliberately set out to produce them. Modern tendency is to commit industrial suicide. There are two outputs going on simultaneously from any business, products and men; the former earns profits, the latter serve a national as well as an industrial end. Plant can be extemporized more rapidly than skill, but if the result is to materially reduce the production of skilled craftsmen, then the industry must ultimately be penalized.

Academic training alone is no substitute, since it cannot produce the practical man of experience nor can it give manual dexterity of a high order. If the industry takes no steps to foster one of the most inherent of human desires—skill in the use of tools—it is going to decay and not to progress. Moreover, the nation which does not produce skilled craftsmen is going to forfeit industrial pre-eminence.

Association and Personal

Lieut. H. W. Morris, M. C., at one time chief electrical engineer of the Grand Trunk Railway, Montreal has been killed in action.

F. W. Darby, formerly advertising manager for Beattie Bros., Fergus, Ont., has been appointed to a similar position with the Waterous Engine Works, Brantford, Ont.

Alexander Wilson Crouch, vice-president and general manager of the Dearborn Chemical Co. of Canada, Toronto, sailed last Saturday on the S.S. Makura from Vancouver, on a year's trade expansion trip to the Orient, Australia, Korea and India. Mr. Crouch came to Toronto from Pittsburgh six years ago.

WATER GAUGE PACKING HINTS

SINCE the introduction of high pressure steam boilers, breakage of gauge glasses has caused much annoyance and given rise to numerous complaints. Many suggestions have been made of introducing substitutes, but the question arises, would the substitute be any better and may the gauge glasses now in use (if of good quality), not be sufficient for all that is required of them? We are of opinion that they are, provided always that the quality is good.

From a large number of experiments with Perth gauge glasses it has been found that these will stand a hydraulic pressure of five thousand lbs. per square inch without breaking. You may take one of them in your hand by one end and insert the other into a flame that will bring it to a red heat in about half a minute, without breaking.

Causes of Gauge Glass Breakage ..

Such being the case, the question naturally arises, why should a glass that will stand the variation of stress above five thousand lbs. hydraulic pressure, be broken with two or three hundred lbs. of steam pressure? To this it might be replied that in the one case the tests are done separately, while in the other the heat and pressure are combined. This looks like a formidable objection, but it is only so in appearance, as it can be proved that the glasses are broken neither by the pressure nor the heat, but by the expansion of the glass being interfered with.

Increased pressure of steam means increased heat, and the heat and pressure combined means an increase in the expansion of the glass. If the glass is packed too tightly, or in any way to interfere with its natural expansion, breakage is unavoidable, for it must break the moment it reaches the point of resistance.

With regard to the packing of gauge glasses, there are a number of points to be noticed; first, you must have a good gauge glass. There are glasses that will not stand two hundred lbs. pressure, pack them how you may. Again, glasses must not be too full for the size of the gland. More glasses are broken from this cause than would be credited, if the totals were known.

In the second place, the gauge cocks must be set perfectly true, otherwise the glass will have too little space for expansion on one side. Further, the packing must be suitable and of the very best quality. Rubber washers, even of first quality are not suitable of themselves, with steam at 200 lbs. or more, because they get softened to pulp in a very short time and are blown out. To prevent this, they should have a ply of asbestos twine or cord on each side.

The next point to be noticed is the screwing up of the glands. You should be able to move the glass with your finger and thumb after the screwing is finished. If you cannot do so the room for expansion is not sufficient and breakage will result. With the glass left easy there will be a little leakage when the steam is put on, but this will take up as soon as the glass and packing expands.

To insure perfect safety, however, it would be as well to slacken the nut almost to the leaking point again. One point to be particularly noticed is, that the glass breaks most frequently at the steam end of the gauge cock, that is because the steam is hotter than the water and causes more expansion. This should be kept in mind when screwing up the glands. If these directions are followed, a good gauge glass should stand perfectly well in the highest pressure boiler that has yet been made.

Gauge Glass Hints

As a proper packing of a gauge glass is so important to engineers and stokers, especially where high pressure boilers are used, the following hints may be found of service.

First, a good gauge glass must be used, which should not be too full for the size of the gland; second, a good rubber washer should be used; protected by a ply of asbestos twine on both sides; and third, the glass should be movable by the finger and thumb after the glands have been tightened up. The steam end of the glass should be left a shade slacker than the water end, and in every case the steam should be turned on gradually; and last, but not least, the whole operation should be carried out with intelligence.

This last instruction is quite as important as any of the others. Experiments have been carried out on a steam boiler with a working pressure of three hundred lbs. At first there were a great many breakages, but experience showed what kind of packing was required, etc., making it afterwards almost impossible to break one.

OPERATOR ORGANIZATIONS

British Columbia Association of Stationary Engineers, Vancouver.—Subordinate Lodges at Vancouver, Victoria, New Westminster, Cumberland, Merritt, and Fernie.

North-West Association of Stationary Engineers, Edmonton, Alta.

Manitoba Association of Stationary Engineers, Winnipeg.

Canadian Association of Stationary Engineers, Hamilton, Ont.—Subordinate Lodges at Montreal, Toronto, Hamilton, Ottawa, Brantford, Guelph, Kitchener, Chatham, Ont.; St. John, N.B.; Owen Sound, London, Stratford, Belleville, Kingston, Sudbury, St. Thomas, North Bay, Port Arthur, Sarnia, and Windsor, Ont. The executive officers of the C.A.S.E. Grand Lodge are as follows:—

Past President—W. G. Forbes, Montreal, Que.
President—R. F. Gofton, Kitchener, Ont.
Vice-President—Wm. Cooke, Belleville, Ont.
Treasurer.—A. W. Heath, Hamilton, Ont.
Conductor—S. Balmfirth, Toronto, Ont.
Doorkeeper—George Moll, London, Ont.
Secretary.—John H. Hale, Hamilton, Ont.

Solder Data.—Suitable solders for any purpose can be made by judicious mixing of several constituents with lead and tin. For use in working at low temperatures, a low m.p. solder can be made by adding bismuth. A mixture of two parts of bismuth and one each of lead and tin melts at about 93 deg. Cent., while by the addition of mercury or alkaline metals, solders fluid at ordinary temperatures can be made. On the other hand, joints to withstand high temperatures can be made with brass, which requires the use of the blowpipe—hard soldering. In selecting a solder with respect to the temperature which the united metals can withstand, it should be borne in mind that the closer the melting points of solder and metals are together the better will be the joint.

The Operators' Point of View

WHAT HAPPENS TO TECHNICAL MAGAZINES

By A. F. Menzies

THAT a large amount of valuable information published in yours and other technical magazines is wasted goes without saying. A considerable reduction in this waste would take place if a convenient means of saving the information were available. If the magazines are preserved in their entirety, the amount of space required for their storage is considerable, and, after being consulted, unless carefully returned to their proper place, an extended search is required to find any given issue. It is rare also, that the title of an article is remembered, the index therefore, is not of much assistance.

Should the bound volume method be resorted to, the storage space required, although less, is still enough to make one think, especially if one has not finished ones wanderings. Further, a caluable part of the magazine, the advertising section, is lost. Clipping files of endless variety have been evolved; but for cheapness and convenience the following is hard to beat, specially for a beginning. After the file has grown large enough to warrant it and the owner thereof feels justified in making the investment, a metal filing case large enough to take the sheets without folding can be purchased.

A box of 250 common envelopes was obtained, the box was used as a filing case and the envelopes used to hold the clippings. It was found more convenient to remove the flap of the envelope. The index was arranged as shown in Fig. 1. By keeping the envelopes in alphabetical order no trouble is found in locating the one desired, and when located, the contents can be read at a glance. Care must be taken that the clippings are returned to the envelope and that the envelope itself is returned to its correct place.

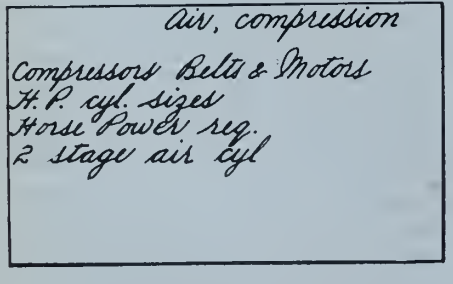


FIG. 1. INDEXED ENVELOPE.

To strengthen the box, strips of ⅜ in. tape were glued on as shown in Fig. 2. Small pieces of tape will also prevent the corners of the lid from cracking.

In reading over the magazines, the desired material can be marked and cut out at some future time, or simply cut out when it is decided that it is liable to be of use. It is as well to err on the side of too many clippings rather than to run the risk of enjoying the doubtful pleasure of kicking oneself for not keeping a certain article. The advertising section of the magazine should not be overlooked. Discounting the fact that the ad. writer is, so to speak, blowing his own horn, there is often as much meat to be found there as in the reading section.

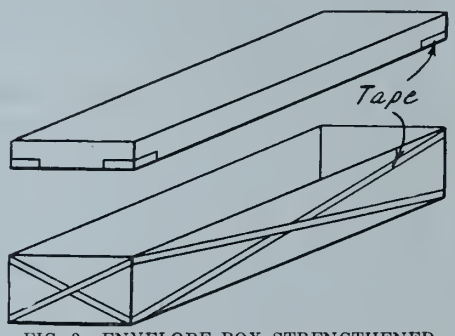


FIG. 2. ENVELOPE BOX STRENGTHENED WITH TAPE GLUED ON.

It sometimes happens that two desirable articles on widely different subjects are printed on the oppoite sides of the same sheet. It can, of course, only be filed under one head. To care for this a title of the other article with a very brief synopsis may be written out and noted thereon the heading under which the article will be found. This slip should then be filed in place of the article.

Such a method of keeping clippings is open to the objection that is applicable to any other thing that is worth while; in other words, to keep it up-to-date, a certain amount of persistence and patience is required.

GRAVITY vs. FORCE-FEED LUBRICATION

By R. Wood.

IN A recent issue of an American engineering journal, a correspondent recommends the old style gravity feed lubricator in preference to the oil pump. The writer presumes he refers to the automatic oil pumps which are stated to be wasteful.

Considerable experience with modern automatic force feed lubricators has shown them the exact opposite of wasteful and in my opinion they possess many points of superiority over the gravity lubricator. Some of these points are as follows:—

It it is desired to introduce a quantity of oil prior to starting a unit, all the operator has to do is to give the ratchet wheel a few turns by the handle placed on the wheel for this purpose.

The oil chamber can be filled and refilled while the unit to which it is attached is in operation and while the pump itself is in operation. If a small piece of sediment finds its way into the oil passage it can be forced out by giving the ratchet wheel a few quick turns.

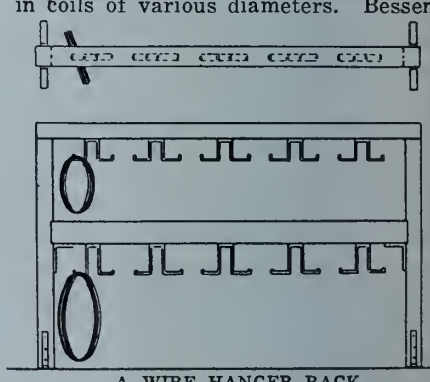
When the unit is started the pump starts feeding. When the unit stops the oil flow stops; there are no valves to open or close, no water to be drawn from the oil chamber.

The pump can be set to feed one drop a second or one drop a minute, that is, any speed of flow desired by the operator, and to regulate this flow all that is required is a turn or two on a regulating screw. This screw is the only thing the operator has to move. It requires about the same amount of work to install an automatic oil pump as it does to connect up a gravity automatic lubricator.

A WIRE HANGER RACK

By A. M. Y.

WIRE that is used for making springs and rivets, etc., usually comes wound in coils of various diameters. Bessemer spring wire coils being considerably larger of course than music wire. It is the usual practice to store these coils either on top of one another, or stand



A WIRE HANGER RACK.

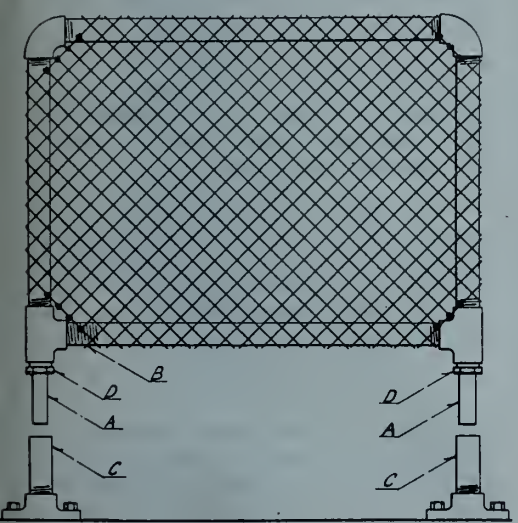
them endwise one against the other near a wall. In this manner they are hard to get at, besides, the ends become entangled with other coils and considerable difficulty is experienced in trying to separate them.

In the accompanying sketch is shown a wire hanger rack which is a very neat and convenient arrangement for hanging wire separately on books, whereby the coils are kept free from each other and are easily accessible when wanted. The rack is made from two by four lumber about 10 feet long, and 5 feet high. The lower rail is supported on the end by a forged bracket, and also four brackets support and hold the two uprights to the floor. The top rail is used for holding coils of small diameters, and the lower rail for larger diameters. The rack occupies very little space. The coils when placed on the hooks are turned slightly inward as shown in the top view of the sketch.

SIMPLE AND EFFECTIVE FLYWHEEL GUARD

J. E. N.

IN addition to the necessity of effective protection from the dangers contingent to machine shop and power house mechanisms, it is often advisable to make



SIMPLE AND EFFECTIVE FLYWHEEL GUARD

ample provision for the temporary removal of guards for repairs, cleaning up, etc. The guard shown herewith was installed to protect workmen from the flywheel on an engine, but same could be applied in any other dangerous location. As shown, the frame consists of 1½-inch pipe connected with standard fittings. Owing to the continuous construction of the frame, the last joint shown at B was made with an extra long thread so as to avoid left-hand fittings. In the outer end of each tee was placed a 1½-inch to 1¼-inch bushing D, into which was secured a short length of 1¼-inch pipe A, previously turned to a diameter that would slip into the short piece of 1½-inch pipe, screwed into the supporting wall or floor flange. The frame is covered by 1¼-inch mesh wire screen, a feature that prevents the hand or arm from being thrust through in case of a fall. A frame of this description can be readily lifted from its position for necessary repairs, the supports remaining fixed to the wall or floor.

KEROSENE AS MOTOR FUEL

By C. T.

IT is evident that the day is not far distant when kerosene will be as commonly used in engines of motor cars and tractors as gasoline is at present. The search for another substitute than that of some petroleum product has been an utter failure. It began with the high price of gasoline some four years ago, and has been continued ever since. Various suggestions have been made and numerous times it has been reported that a substitute had been found which would furnish cars with a cheap fuel and drive gasoline out of business. It will be remembered that English inventors were sure a few years ago that they could substitute benzol for the American article, but they never carried the demonstration beyond a few cars, because the article was too scarce and too costly. An American inventor drove cars round the race track in Indianapolis for several weeks with a fluid that could be produced at the small cost of a few cents a gallon. It was a failure in the end. Last year a Long Island chemist had a green fluid, which, added to water produced at any pump or creek, promised relief from high-priced gasoline. He drove cars with it, or with something, and even deceived several noted inventors. The green fluid suddenly disappeared from public prints, and the auto owners waited for some other inspired article.

Meanwhile inventors turned their attention to the use of the cheaper kerosene as a substitute. Engines have since then been run on kerosenes with the introduction of small amounts of water in the cylinders. This has been practically demonstrated in a factory in Allegany County, New York, and two years ago a car crossed the Continent with no other motive power than kerosene. A few months ago a car was taken from Warren, Pa., to New York over heavy roads and through bad weather, and with no other fluid than was obtained from the kerosene stores along the route. The facts prove the possibility of the use of the heavier article for autocars and other engines.

It is now recognized that only slight changes are needed in the carburetter to make the use of kerosene as common as that of gasoline. This is also proved by the fact that much of the gasoline now used is the same specific gravity as the lighter grades of kerosene of the past years. The gravity of gasoline has been gradually lowered to meet the demand for more motive power for automobiles, aeroplanes and motor boats, and the engines built at present handle it freely. Necessity has brought this about, and with the awakened interest in the heavier article the demand will be met.

DOES A PISTON STOP AT REVERSAL?

By R. W. Miller.

HERE is an interesting question about which a controversy has arisen in connection with recent litigation. Put into its simplest form, the question is—does the piston of a steam engine stop when its direction is reversed, this is assuming that there is no lost motion in the parts?

Strange as it may seem. engineers, attorneys and examiners in the Patent Office disagree on the question. I maintain that it does not stop, but that the motion is continuous, and I would be interested if some reader of the POWER HOUSE can prove that I am wrong. To stop means to produce a state of rest—in other words, then, if the piston stops it must rest—then, how long does it rest?

The curve of a piston's motion, provided the connecting rod were of infinite length, would be truly harmonic. According to one authority, "a harmonic motion may be defined as the motion executed by the foot of a perpendicular let fall on the diameter of a circle from a point moving with uniform velocity along the circumference."

It is unnecessary to reproduce here a harmonic curve, because it is one with which we are all familiar. We know that no portion of this curve contains any part of a straight line. Now if there were a rest at each end of the stroke there would be two flat portions at each extreme of the travel parallel with the base line. One flatly contradicts the other.

One man argued that there was a point where there would be no motion; what becomes of this argument when we know that a point has no magnitude? Finally, if the piston stopped even for an infinitesimally small fraction of a second would not the flywheel to which it is connected stop also?

To controvert the theory that the flywheel stops, we find in the definition quoted that the point executing the harmonic motion must move with uniform velocity. How can the flywheel stop twice in one revolution, and yet have any point in its circumference move with uniform velocity?—the motion of the piston is just as continuous as the flywheel.

STEEL CHIMNEY TROUBLES

By T. J.

CHIMNEYS built up of steel plates require protection both inside and outside, if they are to have reasonably long life and perform their work properly. The outside of a chimney is exposed to the action of sun, wind and rain, and the approved method of protecting it from rust is to give it a coat of good paint, which should be renewed whenever and wherever it shows signs of peeling off and exposing the metal to the influence of the elements. On the inside the chimney is exposed to the action of the gaseous products of combustion, which may have a temperature of several hundred degrees. Any form of paint would, therefore, be quite useless. Besides it

must be remembered that the gases which flow up the chimney are derived from the combustion of fuels containing carbon, hydrogen, and sulphur, and, therefore, contain carbon dioxide. steam and sulphur dioxide. The steam in the chimney gases will condense if cooling takes place to any great extent, and the moisture will combine with the dioxides of carbon and sulphur to form carbonic acid and sulphurous acid. Both of these acids are corrosive in their action on iron, and they are particularly active in the presence of heat. Therefore, the inside of the chimney needs to be well protected.

The usual method of protecting the interior of a steel chimney is to line it with brick, which is laid up against the wall of the chimney. It is advisable to fill the interstices between the lining with a grout made of cement, as this will not only give support to the brickwork, but will at the same time prevent the corrosive acids from reaching the shell. Such a lining should extend to the top of the chimney to be effective. If it is carried up only half-way or even to two-thirds of the full height of the chimney the corrosion is localized at the part of the structure that it is most difficult to reach. The formation of moisture, due to condensation of vapor in the flue gases, will occur in the upper part of the chimney rather than in the lower, because the gases grow colder as they ascend, due to radiation from the shell of the chimney. It is, therefore, very advisable to carry the lining all the way up to the top.

It will be found upon observing steel chimneys that are in service that the signs of discoloration and corrosion on the outside are largely confined to the upper half of the structure. The rings or sections composing the chimney are put together in such a way that each overlaps on the outside of the ring below it, so that the edges of the circumferential seams face downward outside. This construction prevents rain and snow from collecting on the edges of the plates outside. On the inside, however, the edges face upwards, and if moisture is formed it will lodge on these edges, find its way through the joint and run down outside, streaking and discoloring the chimney. A continuous lining from the top to the bottom will lessen the radiation loss, reduce and perhaps eliminate condensation and in any case eliminate the moisture from the edge of the plates.

TEMPORARY REPAIRS TO GAS ENGINE GOVERNOR

By J. E. McCormack.

IN a gasoline engine governor of the type shown in section in Fig. 1, the arm A, broke at the hinge pin. Weights DD were connected by springs, as indicated in Fig. 2. Before the engine stopped, one of these springs became badly stretched, but was put back as well as possible later. For a temporary quick repair, a piece of wood was cut as in K. Fig. 3, the side projection being shaped to fit down against the balance wheel hub and into the space between the spokes and was then attached to the yoke E, Fig. 1, by means of a suitably

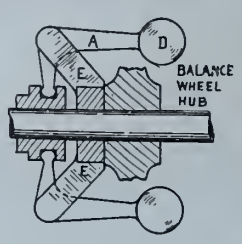


FIG. 1.

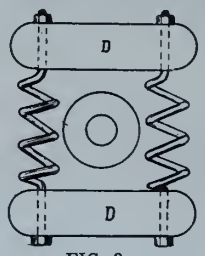


FIG. 2.

bent carriage bolt shown in Fig. 4. Smaller bolts were dropped into the springs FF (one into each spring), and a washer slipped between two coils of each spring and above the ends of the aforementioned small bolts. These bolts were then passed through the washers and through the wooden piece K, and washers and nuts put on these. The washers in the springs were large enough to hold the springs to K, yet small enough that the bolt heads did not pull through them.

After being planned, the repair did not require much time for its accomplishment, and the engine was again started. According to the speed indicator, it ran about eight per cent. slower than normal when first started, which was not considered bad, considering the stretched condition of the springs. They were, however, tightened a little more and operations continued; although the engine did not run quite so steadily as formerly, it was considered much better than shutting down to await new parts. The one weight acting alone against K. instead of against a duplicate of itself was much like one pulling on a rope tied to a post as compared with his pulling against another man on the some rope. The two pulling equally merely balance each other, the strain would be equal to

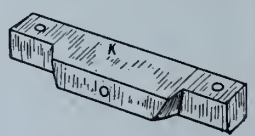


FIG. 3.

FIG. 4.

the pull of one and the same as though the other end were fastened to something solid.

I might also add that with this engine a cord was passed from the ignition switch up through a pulley and across to where the operator of the driven machinery could easily reach it and thus cut out the ignition and so stop the engine whenever he wished. Also the priming bottle used was decorated with a large diamond shaped red label to prevent anyone mistaking the contents for kerosene or other liquid.

Charles, aged five, having been told that baby sister had just arrived from heaven, marched into the room and said: "Now, Miss Baby, tell us all about heaven 'fore you forget it."

Screenings

Proud mother of young Corporal Jones: "You've heard about my boy, of course, Mrs. Evans?"

Mrs. Evans: "No. What is it?"

Mrs. Jones: "Why, just think—they have made a cockerel of him!"

"And how do you find school, Harold?"

Rather difficult, sir. The teachers are inconsistent. In English composition we are told to be original. In arithmetic we are all expected to get the same answer."—Louisville Courier-Journal.

A nervous man at the opera sat behind a pair of those persons who explain the plot until his endurance was exhausted. Then he leaned forward and said:

"Excuse me, will you speak a little louder? Sometimes the music prevents my hearing what you say."

Teddy had been invited out to tea. He wanted to have the afternoon off from school, but his mother would not hear of it. As his bedtime was 7 o'clock he had rather a short visit, and as he was leaving his hostess said cordially:

"I'm so sorry you've been able to stay such a little while, dear."

Teddy remembered his mother's injunctions to be polite on all occasions, and answered, sweetly: "Oh, it's quite long enough, thank you."

"Dear Clara," wrote the young man, "pardon me, but I'm getting so forgetful. I proposed to you last night, but really forgot whether you said yes or no."

"Dear Will," she replied by note, "so glad to hear from you. I know I said 'no' to some one last night, but I had forgotten just who it was."

A certain learned Queen's counsel was arguing a commercial case before a learned judge. In doing so, he had occasion to speak repeatedly of an "eccentric," and the judge at length asked him what an eccentric was. The magistrate said he was familiar with the term as applied to individuals, but not to things. The Queen's counsel at once complied. "An eccentric," he said, "is a circular disk whose centre is not in the middle."

"I tell you, gentlemen," said the great explorer to the crowd in the hotel smoking room, who were listening breathlessly, "you can't imagine what things are like out in the Arctic regions!"

"Oh, I don't know!" said one. "Even if we haven't seen it, we can imagine what it feels like!"

"I doubt it. It's impossible until you've seen it; until you've stood there, a small, insignificant atom, surrounded by vast stretches of white—"

"Yes, I know. I've been like that."

"Really? Where was it, may I ask?"

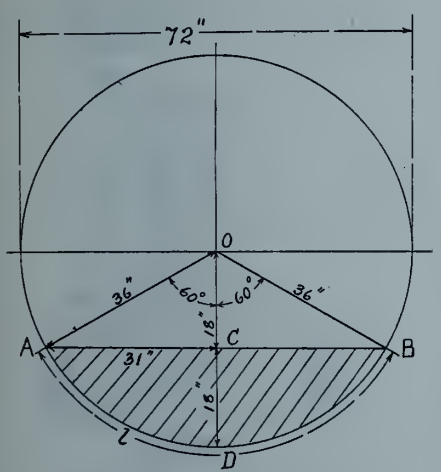
"First time I appeared in public in a dress shirt!"

Operators' Instruction Course

EDUCATION PAPER.—III.

HOW many gallons of water are there in a cylindrical tank 72 in. in diameter by 18 ft. long, which is filled to a depth of 18 in.?

The problem is solved by finding the number of cu. in. or cu. ft. in a body of water 18 ft. long, having a cross section represented by a segment of a circle whose radius is 36 in. and height of segment 18 in. The accompanying sketch shows how the area of the segment is found. The shaded portion ACBD is the segment corresponding to the body of water in the tank, and in



order to find its area it is necessary to find the area of the sector AOBD and deduct the area of triangle AOB. Area of sector AOBD = length of arc ADB × half the radius OD. To find length of arc ADB calculate angle AOB in degrees thus: AO and OB are radii = 36 in.; OC = 18 in.; and sine of angle AOC = 18 ÷ 36 = ½ so that angle AOC = 60 deg. Angle AOB will be twice this = 120 deg.

The circumference of 72 in. dia. = 226 approximately therefore as angle AOB is 120 deg. or one-third of the circle, arc ADB will be one-third of the circumference 226 = 75.3. 75.3 × 18 = 1355 area of sector AOBD. Area of triangle AOB = half the base × height, and half the base = AC = $\sqrt{(36^2-18^2)}$ = 31. Therefore 31 × 18 = 558, area of triangle AOB. Deducting 558 from 1355 leaves 797 area of segment ACBD, in sq. inches. 18 ft. = 216 in. which, multiplied by 797 = 172152 cu. in. The number of cu. in. in an imperial gallon is 277.274 and dividing this into 172152 = 657 1/3 gallons approximately.

(Note). The foregoing shows one method of finding the answer mathematically where a considerable degree of accuracy is necessary. Owing to manufacturing problems it is not possible to get a tank which might agree accurately with calculated results but in any case it would be more accurate than any rule of thumb methods which operate only within small ranges of variation. The question of contents at different depths in horizontal cylindrical tanks is of wide spread interest and in an early issue in hope to publish a chart which by means of simple arithmetic will give accurate figures for any proportion of contents.

* * * *

What horse-power is required to raise 600 cu. ft. of water per min., lifting it 20 ft. and then forcing it to 140 ft. in height, allowing 25 per cent. for friction?

Horse-power equals foot pounds per minute divided by 33,000. The foot pounds here are equal to the weight of water, multiplied by total height in feet through which it is moved: a cu. ft. of water weighs 62.32 lbs., which multiplied by 600 = 37,392 lbs. Multiplying this by the total height in feet, 160 we have 5,982,720 ÷ 33,000 = 181.29. The 25 per cent. allowance increases this by 45.32 making the total horse-power required 226.57.

* * * *

What relation is the decimal point and a whole number to each other? Give demonstrations of same.

When placed after a whole number, the decimal point indicates that whatever figures follow after, represent tenths, hundredths etc. respectively, and in this case does not affect the figures in front of it. When moved to the left past the figures in a whole number, it reduces the value of each to one-tenth. Thus—3.5 is three and five-tenths, 74.26 is seventy-four and two-tenths and six hundredths: .35, pronounced "decimal three five" or "point three five" is three tenths and five hundredths: 7.426 and .7426 are respectively one-tenth and one hundreth of 74.26.

* * * *

Add 12.6798, .0346, 1.32, .0035, 5.3621.

Arrange the numbers as for ordinary addition putting each decimal point immediately below each other and add vertically commencing with the extreme right hand figures only, thus:—1, 5, 6, and 8 = 20; carrying two we have 2, 3, 4 and 9 plus 2 = 20; again, 6, 2, 3 and 7 plus 2 = 20; again, 3, 3, and 6 plus 2 = 14. The 4 is placed under the first column of decimal figures, one is carried over to the first column of whole numbers and the sum finished. Answer 19.4.

* * * *

Subtract 6.6794 from 12.7896, and 145.280 from 176.7.

Proceed as in ordinary subtraction placing decimal points below each other, and where there are no decimal figures to correspond, fill up with ciphers.

Thus:
```
  12.7896
   6.6794
  ------
   6.1102
```

And
```
 176.700
 145.280
 -------
  31.42
```

* * * *

Divide 33 by .055; 55 by .015; 426 by .1278.

Proceed as in ordinary long division and if there is a point in the divisor move it to the right hand end of the number, making it a whole number. At the same time, if there is also a decimal point in the dividend, move it a corresponding number of spaces to the right and insert the decimal point in the quotient as it is reached thus:

(1) .055) 33 (becomes.

```
55) 33000 (600
    330
    ---
      00
```

(2) .015) 55 (becomes

```
15) 55000 (3666.6
    45
    --
    100
     90
    ---
     100
      90
     ---
      100
       90
      ---
       10.0
```

(3) .1278) 426 (becomes

1278) 4260000 (3333.3

Steam Power Plant Auxiliaries

PRESSURE REDUCING VALVES—I.

THE ever increasing complexity of modern manufacturing processes renders it necessary in many factories to use steam at widely different pressures — heating, cooking, dyeing, boiling and drying, etc., are some of the numerous applications with which readers are familiar. Frequent use is also made of reducing valves on board ship, where the high pressure necessary for the main engines is reduced to pressure suited to the various auxiliaries throughout the ship. In both cases, the necessity exists for a device which will automatically control the flow of steam from the

FIG. 1.—EXTERIOR VIEW OF "J.M.T." REDUCING VALVE.

the main engines is reduced to pressures system, operating to close down as the low pressure builds up when not in use, and opening up to pass more steam when additional demands are made on the low pressure system.

In view of the damage which might ensue from an unexpected or uncontrolled rise of pressure in many plants, the necessity of using reliable apparatus will be admitted, and the several types of valves on the market to-day are the result of many years of attention and experiment by makers and users over a wide range of conditions. Usually the initial or high pressure is subject to more or less radiation through [illegible] wide ranges, and, as frequently occurs, the low pressure side is also liable to variation at the same time. This latter condition alone has been one of the most difficult conditions influencing reducing valve design and it has been the aim of all modern designs to meet this condition with the simplest possible mechanism.

"J. M. T." Reducing Valve

An exterior view of this valve is shown in Fig. 1, and a sectional view in Fig. 2, the manner in which the reduced pressure is maintained at the desired degree being understood by reference to the numbered parts thereon. The main valve 19, is held on its seat by spring 18, the upper end of which rests against the fixed socket or bushing 7. This bushing forms a guide for auxiliary valve 8, which seats on the bottom end of bushing and controls the admission of high pressure steam to the port 15, which in turn is connected by a small passage (not shown in cut) to the underside of piston 11 below main valve 19. The upper end of auxiliary valve 8 makes contact with diaphragm 6, the underside of the diaphragm being subject to steam pressure from the reduced side through the passage shown at the left. This pressure is opposed by the action o spring 4 on its upperside, suitable adjustment being obtained by handwheel as shown.

When there is no pressure on either side, the main valve is closed and the auxiliary valve is open. When high pressure steam enters the inlet, it immediately passes through auxiliary valve and ports to the underside of piston 11, which, because of its larger area, raises main valve 19 off its seat and allows steam to pass to the outlet. The pressure on the reduced side now increases to the point at which regulating spring 4 is set, and when slightly in excess of it, raises diaphragm 6 and allows auxiliary valve 7 to close slightly, the upward movement of this valve being obtained from spring 14. This movement reduces the flow of steam to the piston 11, which is a loose fit so as to allow a free leakage to the outlet. When the amount of steam passing the auxiliary valve becomes less than that leaking past the piston, the piston will be pressed down by the pressure of spring 18 on top of main valve, and the flow of high pressure steam reduced accordingly.

This action takes place in greater or less degree, according to the amount of low pressure steam required, the main valve assuming a position which furnishes just sufficient steam to maintain the desired pressure on the low side. Should the outlet be closed the pressure forces the diaphragm up far enough to allow auxiliary valve to close completely, thus removing all supporting pressure from piston 11, and allowing main valve to close tight till such time as the outlet pressure falls and allows diaphragm to open auxiliary valve again.

This valve is made in a full range of sizes and in various styles by the James Morrison Brass Mfg. Co., Toronto, and is furnished for ranges of reduction from 5 to 50 lbs., 50 lbs. to 140 lbs, and 140 to 300 lbs., these being obtained by substituting springs of suitable strength.

Fulton Reducing Valve

This valve is illustrated in Figs 3 and 4, and dispenses with the use of pilot or auxiliary valves. Referring to sec-

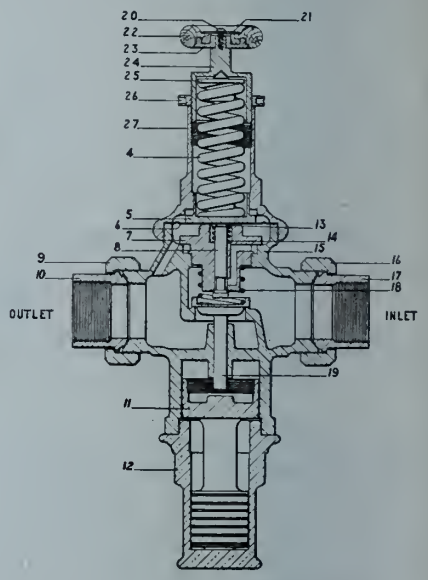


FIG. 2.—SECTIONAL VIEW OF "J.M.T." REDUCING VALVE SHOWING OPERATION OF MAIN AND AUXILIARY VALVES

tional view Fig. 4, it will be seen that a double beat valve is employed. The valve spindle extends upward through a packing gland to a yoke operated by lever and counterweight which tend to keep the valve open. The upper end of the yoke extends into a diaphragm chamber as shown, supporting a diaphragm whose upper side is connected by ⅜-in. pipe to the outlet main, and is thus exposed to the reduced pressure.

As the pressure on the outlet builds up to the desired point, the diaphragm is subjected to increased pressure, which finally overcomes the counterweight and commences to close the valve and reduce the flow of steam to the required amount. An increase of the outlet pressure about that adjusted for will close

the valve entirely and a drop will allow it to open more.

The Chaplin-Fulton Mfg. Co., Pittsburgh, make this valve in from 3-in. to

FIG. 3.—EXTERIOR VIEW OF FULTON REDUCING VALVE SHOWING COUNTERWEIGHT, LEVER, AND CONNECTION TO OUTLET MAIN

12-in. sizes, while below 3-in. the lever and weight are replaced by a long coil spring, which, with the diaphragm, is arranged below the valve body, the outlet pressure being conveyed to the upper side of the diaphragm directly through the body casting. The lever on the large sizes is balanced on a knife-edge fulcrum and supports the valve stem by means of a toggle connection which reduces friction and insures quick response to the slightest change of load.

Ohio Brass Pressure Regulating Valve

All of the several types of this valve operate on the same principle, employing a single seated main valve, and dispensing with weights, dashpots or pistons. It is operated by controlling the relation of pressures on the two sides of a metallic diaphragm, which is attached to the stem of the main valve. The control of these pressures is accomplished by a small controlling valve, which in turn is operated by the service pressure acting on one side of a small metallic controlling diaphragm against a controlling spring on the other side of the diaphragm. The operating and controlling diaphragms are both metallic and their movement is restricted within their elastic limit to avoid any danger of permanent distortion, the difference in pressure between the upper and lower sides of the operating diaphragm is never greater than about 15 lbs., and ordinarily is maintained at about 10 lbs.

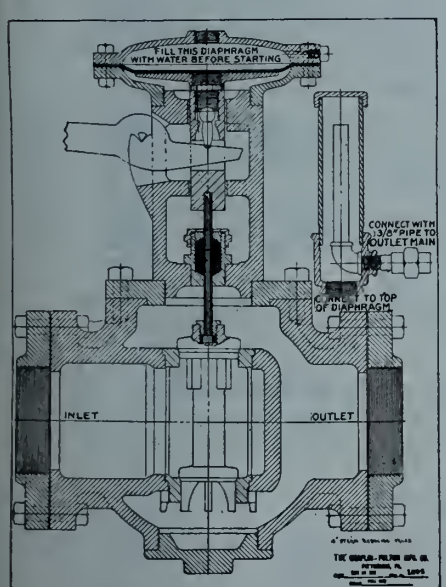


FIG. 4. SECTION OF FULTON REDUCING VALVE SHOWING DIAPHRAGM AND KNIFE EDGE CONNECTION TO COUNTERWEIGHT LEVER.

The type F valve illustrated in Fig. 5. is adapted to pressure from 0 to 15 lbs., 5 to 20 lbs, and 25 to 100 lbs., in sizes from ½-in. to 2-in. When high pressure steam enters the valve body at A, it passes up between the stem of the main valve 13, and guide nut 15 to the chamber E below operating diaphragm 19, and at the same time obtains access to the upper side D of the diaphragm through the internal ports C in the stem of the main valve. Thence it passes by way of passage F and external pipe 23 to controlling valve 25, which is held open by the upward pressure of adjusting spring 30, and thus allows the steam from the upper space D to pass right through to the low pressure side B of the main valve.

The difference in pressure between the upper and lower sides of the operating diaphragm forces the diaphragm upward compressing spring 14, and opening main valve to allow passage of steam to outlet. As the low pressure builds up, it acts against adjusting spring 30, through controlling diaphragm 27, so that controlling valve 25 closes when the reduced pressure is reached.

The closing of this valve prevents any further flow of steam through passage from the upper side of the operating diaphragm, so that the pressures on each side of it equalize and allow spring 14 to close the main valve. Adjusting spring 30 allows the controlling valve to close at any desired pressure with its range of adjustment; in actual operation, of course, the controlling valve does not close completely, but alters its position according to the flow of steam through the outlet—when the latter increases, the drop of pressure allows diaphragm 27 to rise so that the pressure in space D above the large diaphragm is reduced and the main valve allowed to open up more due to the greater difference of pressure between the two sides. The reverse action takes place when the outlet flow is reduced and the reduced pressure rises, the main valve floating and adjusting its opening continuously to the demands for steam on the reduced pressure side.

This valve is made by the Ohio Brass Co., Mansfield, O., who embody the same principle in type G valve, sizes 2½ in. to 4 in., which has a balanced main valve and other changes demanded by the increased capacity.

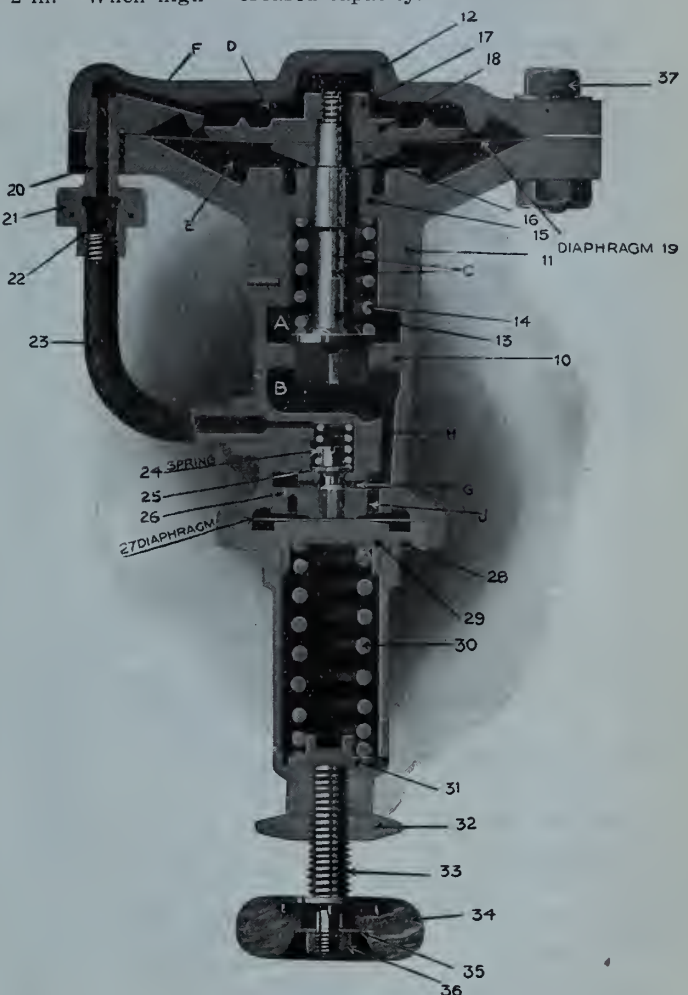


FIG. 5. SECTIONAL VIEW OF "OHIO" BRASS VALVE SHOWING LOCATION OF PARTS.

A NOVEL method of repairing worn armature shafts on the commutator ends of its motors is being employed by the Elmira Water, Light and Railroad Company. Steel tubing, which has an outside diameter equal to that of an unworn armature shaft, plus a very thin skin cut, is employed, and the worn shaft is turned down so that the tubing can be put over it with a shrink fit. To ensure a tight fit between the sleeve and the shaft a circular groove is cut in the end of the shaft along the joint between the steel sleeve and the shaft. This groove is then welded full of metal and the shrink fit and the weld are said to give the required strength.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$33 00	.....
1¼ in.	36 00	.....
1½ in.	38 00	32 00
1¾ in.	38 00	32 00
2 in.	45 00	33 00
2¼ in.	48 00	35 00
2½ in.	50 00	38 00
3 in.	58 00	45 00
3¼ in.	.....	53 00
3½ in.	70 00	55 00
4 in.	82 00	67 00

Prices per 100 feet, Montreal and Toronto

BOILER PLATES.

	Montreal	Toronto
Plates, ¼ to ½	$12 00	$12 00
Heads	12 30	12 30
Tank plates, 3-16 in.	12 65	12 25

WROUGHT PIPE

Effective July 5, 1917

Size	Black Standard Buttweld	Galvanized Standard Buttweld
	Per 100 feet	
⅛ in.	$ 5 00	$ 6 50
¼ and ⅜ in.	5 12	7 16
½ in.	6 46	8 03
¾ in.	8 17	10 29
1 in.	12 07	15 22
1¼ in.	16 33	20 59
1½ in.	19 53	24 61
2 in.	26 27	33 12
2½ in.	42 12	52 94
3 in.	55 08	69 23
3½ in.	69 92	86 94
4 in.	82 84	103 00
Standard Lapweld		
2 in.	29 23	35 71
2½ in.	43 88	54 11
3 in.	57 38	70 76
3½ in.	71 76	89 70
4 in.	85 02	106 28
4½ in.	96 52	121 29
5 in.	112 50	141 34
6 in.	145 90	183 36
7 in.	190 40	238 00
8L in.	200 00	250 00
8 in.	230 40	288 00
9 in.	276 00	345 00
10L in.	256 00	320 00
10 in.	329 60	412 00

Prices—Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 7½%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 40; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 50%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$5 25
Steel bars, base, Toronto	5 50
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	5 25
Steel bars, base, Montreal	5 50
Reinforcing bars, base	5 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28	$11 00	$11 00
Sheets, Black, No. 10	11 50	11 50
Canada plates, dull, 52 sheets	11 00	11 00
Canada plates, all bright	12 50	12 50
Apollo brand, 10¾ oz. galvanized	12 25	12 09
Queen's Head, 28 B.W.G.	11 75	10 75
Fleur-de-Lis, 28 B.W.G.	11 75	10 75
Gorbal's Best, No. 28	12 00	10 25
Colborne Crown, No. 28	11 25	10 00
Premier, No. 28 U.S.	13 75	12 70
Premier, 10¾ oz.	13 85	13 00

PROOF COIL CHAIN B

¼ in.	$12 00
5-16 in.	11 50
⅜ in.	11 15
7-16 in.	10 90
½ in.	10 70
9-16 in.	10 70
⅝ in.	10 50
¾ in.	10 40
⅞ in.	10 25
1 in.	10 10
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	40
Delta Files	37½
Nicholson	40
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	40
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal.	26½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 50
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	11

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 50
Leather in sides	1 35

COAL AND COKE.

Solvay Foundry Coke	$13 05
Connelsville Foundry Coke	14 00
Steam Lump Coal	7 25
Best Slack	6 50

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers ... list plus	10
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass ... add	20
Machine screws, o. and fil. hd., brass ... add	25
Nuts, square blank ... add	$1 50
Nuts, square, tapped ... add	1 75
Nuts, hex. blank ... add	1 75
Nuts, hex. tapped ... add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	17½
Boiler rivets, base ¾" and larger ...	$7 60
Structural rivets, as above	750
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	$0 37
Solder, guaranteed	0 40
Babbitt metals	18 to 70
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	4 35
White lead, pure, cwt.	19 00
Red dry lead, 100-lb kegs, per cwt.	15 45
Glue, English	0 38
Gasoline, per gal., bulk	0 31½
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	0 61
Linseed oil, raw, single bbls.	1 49
Linseed oil, boiled, single bbls.	1 52
Lead wool, per lb.	0 15
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A. ... list plus	20
Emery Cloth ... list plus	33 1-3
Borax, crystal	15
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granular	0 15
Wood alcohol, per gallon	2 15
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$55 00	$53 00
Plain sheets, 14 oz., 14x28 in., 14x60 in.	55 00	53 50
Copper sheet, tinned, 14x60, 14 oz.	60 00	54 25
Copper sheet, planished, 14x60 base	64 00	60 00
Braziers', in sheets, 6x4 base	55 00	52 00
Tubing, seamless	58 00	58 00

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 55
Brass sheets 8" wide, 20 oz.	0 60
Brass tubing, seamless	0 57.
Tubing, I.P.S., 1" base	0 54

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto 25%

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White Cents per lb	
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	35
Sq. & Hex., Head Cap Screws	30
Rd. & Fil Head Cap Screws	10
Flat ⅞ But. Hd. Cap Screws plus	10
Fin. & Semi-fin. nuts up to 1 in.	35
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	30
Fin. and semi-fin. nuts, over 1½ in., up to 2 in.	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets ... list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws ... list plus	20
Collar screws ... list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts ... add 40,	10
Cold pressed nuts to 1½ in. ... add	$4 50
Cold pressed nuts over 1¼ in. ... add	$7 00

METALS.

	Montreal	Toronto
Lake copper	$33 00	$34 00
Electro copper	33 00	34 00
Castings, copper	32 00	33 00
Tin	61 50	64 00
Spelter	10 50	11 00
Lead	13 00	13 00
Antimony	20 00	20 00
Aluminum	67 00	64 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided	0 34
Packing, No. 1 Italian	0 40
Packing, No. 2 Italian	0 32
Pure Manila rope	0 37
Transmission rope, Manila	0 43
Drilling cables, Manila	0 39

LEAD SHEETS

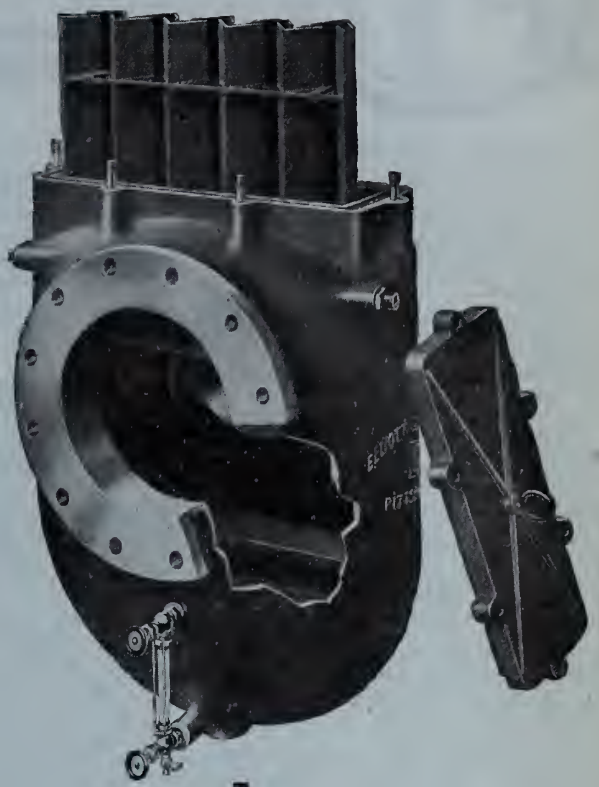
	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$18 00	$18 00
Sheets, 3½ lbs. sq. ft.	18 00	18 00
Sheets, 4 to 6 lbs., sq. ft.	17 50	17 50

Cut sheets, ½c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

ELLIOTT
Oil Separators

Have baffle plates that can be removed from the Separator and cleaned when they become gummed with oil.

The double row of V-Shaped baffle plates in Elliott Oil Separators, Type "P," collect the particles of oil and conduct them out of the path of the steam.



Type "P"
Oil Separator
showing how the baffles may be removed for cleaning.

In some types of Oil Separators a flat or corrugated baffle plate is interposed in the path of the steam—the idea being that the particles of oil which are traveling at an enormous velocity will hit it head-on and in some manner or other be so broken up that they will cease to exist. The impact or collision may serve to break up the particles of oil into still smaller particles, but little is accomplished toward getting the oil out of the steam as the particles of oil will rebound back where they can be picked up again and carried on with the steam.

A similar action will be observed if you direct a stream of water under pressure against a wall at right angles to the flow of water. The impact breaks up the stream into hundreds of small drops, which rebound back in all directions. If the stream of water were directed against the wall at an angle, practically all of the water would be deflected in the same direction.

This is the principle of the V-shaped baffle plates in the Type "P" Oil Separators. The first row merely directs the stream at the proper angle against the second row of baffles which in turn throws the particles of oil back into the recess angles of the first row so that the oil is completely out of the path of the steam.

The baffle plates are kept moistened with jets of water from a spray pipe (see spray pipe connection at side of accompanying cut.) With the baffle plates in a moist condition the particles of oil readily form into globules or large drops and run down into the reservoir.

The first step in learning more of the Elliott Oil Separators is sending for Bulletin "E." It is yours on request.

ELLIOTT COMPANY

6902 Susquehanna Street Pittsburgh, Penna.

If any advertisement interests you, tear it out now and place with letters to be answered.

Projects and Developments

Kingsville, Ont.—The Town Council contemplate installing a pumping plant.

Port Dover, Ont.—The Town Council will proceed with the installation of a waterworks system now that the by-law has carried.

Portage la Prairie, Man.—The Town Council will install a 100 h.p. boiler with mechanical stoker in its electric station at a cost of $5,000.

Oshawa, Ont.—A contract has been awarded to the Chapman Valve Mfg. Co., Toronto, for the valves required for the filtration plant being built here.

Drummondville, Que.—The Southern Canada Power Co. have awarded a contract for a 400-h.p. single vertical turbine to the S. Morgan Smith Co.

Dorval, Que.—The Norwood Engineering Co., Cowansville, Que., have been awarded the contract for filtration plant to be installed here at a cost of $35,300.

New Toronto, Ont.—James, Loudon, & Hertzberg, the town's consulting engineers, have recommended the purchase of a small motor-driven centrifugal pump.

Toronto, Ont.—The directors of the Canadian National Exhibition may decide to build an auxiliary electrical power plant of their own in the near future.

Pointe Claire, Que.—The Town Council have awarded a contract to the Turbine Equipment Co., Toronto, for 2-motor driven De Laval single stage pumps, for the municipal filtration plant.

The Turbine Equipment Co., Toronto, have received an order for a 125 h.p. motor driven De Laval 2 stage pump, from the city of Belleville, Ont. This is the fourth De Laval unit purchased by this city.

Oshawa, Ont. — The Turbine Equipment Co., Toronto, have secured a contract from the Town of Oshawa, for 2-De Laval single stage, motor driven centrifugal pumps, for the new filtration plant which is being constructed here.

Yorkton, Sask.—The Siemens Co. of Canada, Ltd., Montreal, have been awarded a contract for a generator to be direct connected to a Diesel engine. The generator will be 400 k.v.a., 60-cycle, 3-phase, 220 volt. A direct connected exciter is also included in the contract.

The Yamachiche Electric Light Co. has been incorporated at Ottawa with a capital of $100,000, to operate an electric light and power plant at Three Rivers, Que. The incorporators are: J. E. Marier, J. E. Cadotte and E. Cherette, all of Montreal.

Dundas, Ont.—The Canadian Engineering & Contracting Co. of Hamilton has been awarded the contract for repairing the waterworks reservoir. The tender was $2,808, the lowest received. The work will be commenced in two weeks' time.

Brantford, Ont.—The City Council have awarded a contract to the Turbine Equipment Co., Toronto, for 2-De Laval single stage, motor driven pumps, for the booster pumping station. This is the second order within the last three years for De Laval pumps for this city.

The Turbine Equipment Co., Toronto, have recently secured the following contracts. One motor driven multistage De Laval pump for operating against 400 feet head, for the mining corporation of Canada, Cobalt, Ont. A similar unit for operating against 450 feet head for the Casey-Cobalt Silver Mining Co., New Liskeard, Ont. Two De Laval steam turbine driven centrifugal pumps for the new Union Station, Toronto.

Nelson, B.C.—A new light and power corporation has been organized known as the Northport Power and Light Co., to supply light and power to this district. Its principal place of business will be Northport, and branch offices will be maintained both in the United States and Canada. One of the directors is Lorne A. Campbell, of the West Kootenay Light and Power Co.

St. John's, Nfld.—R. H. Reid, vice-president of the Labrador Pulp and Paper Co., is credited with saying that the undertaking would mean the development of one of the most important water powers in the country, the falls on the Hamilton River are second to those of Nagara. The bonds of the company will not be placed on the market, and the increased capitalization will all be met by private subscription.

Toronto, Ont.—Tenders will be received, addressed to the Chairman, Board of Control, City Hall, Toronto, up to October 2, for the construction and delivery of stop valves, valve operating, pump and special castings, for main pumping station. Specifications and forms of tender may be obtained at the Works Department, Room 12, City Hall.

Toronto, Ont.—Hon. F. G. Macdiarmid, Minister of Public Works, announced the other day that a beginning had been made on construction of the necessary plant at Lakes Nipissing and Nepigon for the handling of fish caught in those waters under the new fisheries plan of the province.

CATALOGUES

The Canadian S K F Ball Bearing Co., Toronto, have for distribution among their friends a handy pocket rule in English and metric measurements. The rule is 6¼ inches long and will be gladly mailed to anyone interested in ball bearings.

The S. K. F. Ball Bearing Co., Hartford, Conn., have issued a folder containing photographs and statements from a number of prominent machine tool manufacturers giving their opinion concerning the use of S K F ball bearings on the machines which they make.

Firebox Boilers. — Catalogue No. 62 issued by the Dominion Radiator Co., Toronto, illustrates and describes the Safford-Kewanee firebox boilers for steam and water heating. The catalogue also contains specifications pricelists and sectional views of boiler settings.

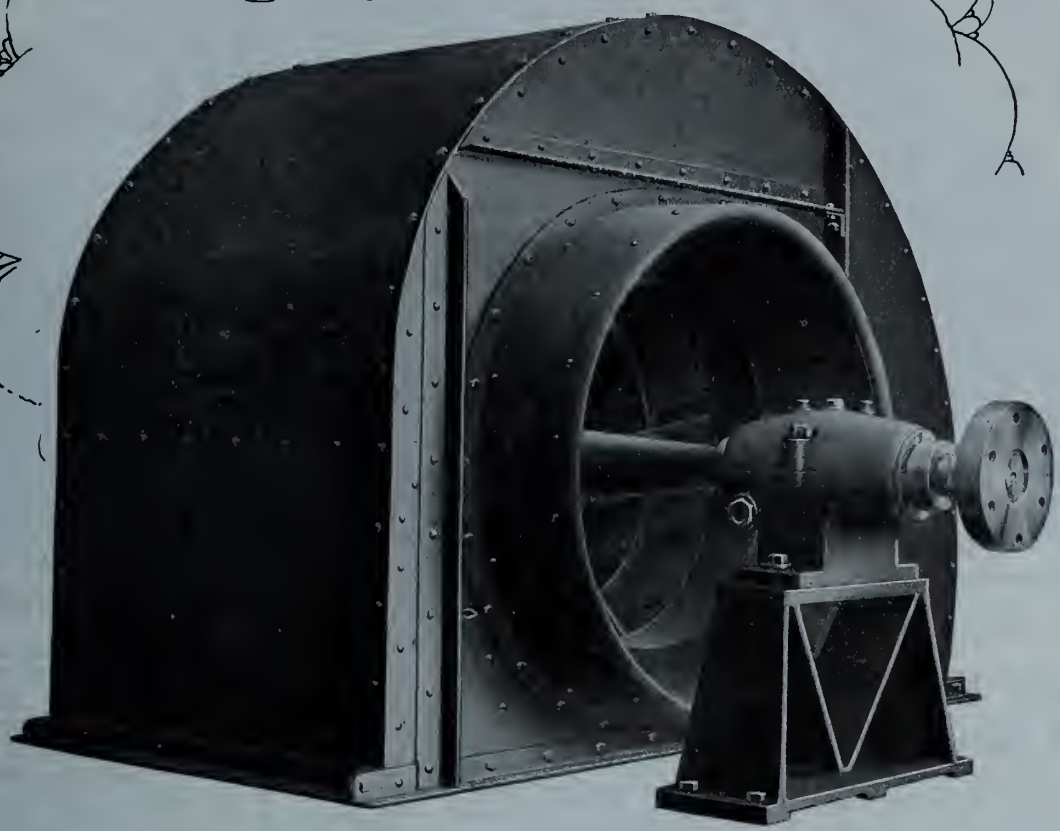
"Mor-Lite" Plant.—Canadian Fairbanks Morse Co., Montreal and Toronto, have issued an attractive booklet illustrating their Mor-Lite self-starting, self-stopping and self-running electric light generating plants for private use. Complete specifications of the plant are given, and its compactness combined with convenience for country homes are the chief features.

Darling Bros., Ltd., of Montreal, Que., manufacturers of steam appliances, have recently issued a special catalogue for distribution abroad. This booklet is 6 by 9 in. in size, containing 24 pages, and printed in French on high-quality calendered stock. Many of the lines manufactured and handled by this firm are profusely illustrated and described, with the data and prices arranged and compiled to meet the requirements of foreign countries familiar with the French language.

Engine Room Supplies is the title of a booklet recently issued by the Quaker City Rubber Co., Philadelphia, Pa. This booklet is exceptionally complete and comprehensive, and will serve as a useful guide to the engineer in selecting packings, hose and other necessary engine room requirements. The principal lines described include Daniels', P. P. P., rod packing, Ebonite sheet packing, gaskets and steam hose, "Crown" and "Quaker City" packings. The booklet is pocket size and contains 63 pages with index.

A Chain of Evidence is the title of publication No. 14, dealing with large power drives manufactured by the Morse Chain Co., Ithaca, N.Y. The bulletin illustrates and describes a num-

Announcing the Design 4 Turbovane Fan



The Sturtevant, Design 4, Turbovane Fan is a new development for high speed forced draft work.
It has an exceeding high efficiency, not only at full load but over the entire useful range. The efficiency curve is practically flat between ¾ load and 1¼ load, which gives high operating efficiency over a wide range of conditions—either at peak load, full load, or when operating below normal.
Engineers familiar with the very varying loads in power plants and with the changing demands upon the fan, will realize the immense importance of a fan with this characteristic.
Our engineers will explain more on request.

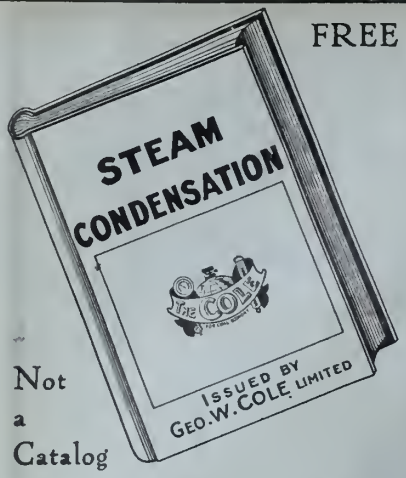
B. F. STURTEVANT COMPANY OF CANADA, LIMITED, Galt, Ontario

Montreal Toronto Winnipeg Vancouver

Selling Agents Sanford Riley Stoker Co., Limited, "THE RILEY STOKER"

Sturtevant

(TRADE MARK)



FREE

Not a Catalog

Read This Book

Tells in plain, easily understood language how users of steam can AVOID LOSSES. Factory managers, superintendents and engineers grasp instantly the full meaning intended.
This book is a genuine work of instruction, and was compiled by Geo. W. Cole, Toronto, and written by Wm. H. Rose, consulting engineer and high authority on steam condensation. There is a big demand for the book. Get yours before it's too late.
Correct Way to Handle Condensation.
Saving Fuel (with examples).
How to Get Water to the Boiler.
Lost 37 Degrees.
Lost a Million Gallons of Water.
Loss of 16 per cent. of the Heat.
Economical Use of Steam.
Increased the Output and Reduced the Cost.
How it was Done.
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Machinery Deserves Good Lubrication

The initial cost of good lubrication is negligible when compared with the ultimate cost of poor lubrication.

DIXON'S
GRAPHITE CUP GREASES

have a reputation for quality and service. A perfect mixture of selected flake graphite and mineral grease is the reason.

Let us know your lubricating problems and we will tell you how to solve them.

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JOSEPH DIXON CRUCIBLE COMPANY

ESTABLISHED 1827

Sole Canadian Representative:
CANADIAN ASBESTOS CO.
Montreal, Que.

ber of important Morse chain installations in various plants showing the wide field of application for transmitting large powers. The bulletin also deals with the construction of the Morse chain and the advantages obtained by its use for large power drives. Copies of this publication may be obtained from the Canadian agents Jones & Glassco, Montreal.

Steam Pumps.—A 90 page catalogue No. 12, issued by the Smart-Turner Machine Co., Hamilton, Ont., is devoted to steam pumps and covers only the designs and sizes ordinarily called for. The catalogue, however, deals with a varied line and includes pumps for practically all purposes. Each type is illustrated, while tables are included, giving sizes and capacities, etc. The concluding pages contain useful hydraulic tables, directions for installing and operating Smart-Turner pumps, and also directions for setting steam slide valves of the duplex pumps.

BOOK REVIEW.

The Economical Purchase and Use of Bituminous Coal for Heating Homes.—The University of Illinois has issued a circular dealing with the economical operation of small house heating plants and the saving in coal that can be effected. The University of Illinois has discussed, in the circular referred to, the more important factors involved in the installation of a satisfactory house heating system, and has set forth the most economical methods of firing soft coal and operating a house heating plant. The properties of fuels, and the proccesses attending their combustion are discussed in a fashion which is intended to help the average householder to understand his problem and to secure the economics of intelligent operation. Copies of this circular may be had by addressing the Engineering Experiment Station, Urbana, Illinois. The price is ten cents.

Progress in Water Works Pumps.—Waterworks pumping plants have recently undergone a rapid and radical evolution. The tremendously heavy and expensive, although efficient, triple-expansion pumping engine has given place to the more compact, simple and less costly steam-turbine-driven centrifugal pump. The efficiency of the latter has risen steadily with the experience of its builders and with improvements in auxiliary equipment, until duties under standard steam conditions exceeding 150,000,000 ft. lb. per 1,000 lb. of steam are now obtained. The De Laval Steam Turbine Co., of Trenton, N.J., builder of the largest pumps of this type, has just issued, under the title "Progress in Water Works Pumps," a 48-page booklet discussing the general economic and engineering conditions affecting the design and installation of such pumps. Installations in 15 of the principal cities of the States and Canada are described, including 34 units aggregating 999,000,000 gals. per day capacity.

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CYLINDER OIL
MANUFACTURED ONLY BY
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FRICTION LOSS

You may have attributed your friction losses to everything else but your oil. Yet nine times out of ten that is the source. An oil that is purely oil, perfect in its lubricating qualities, and free from all imperfections, should eliminate all friction; make a noticeable reduction in your coal bill; lessen oiling and firing costs; promote speed, and prove the source of greater efficiency to the whole system. If your oil is not performing these duties—consult us. Kellogg Non-Corrosive Cylinder Oil is being used by a great many of Canada's leading manufacturers for the above points. Consult us.

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WHAT?

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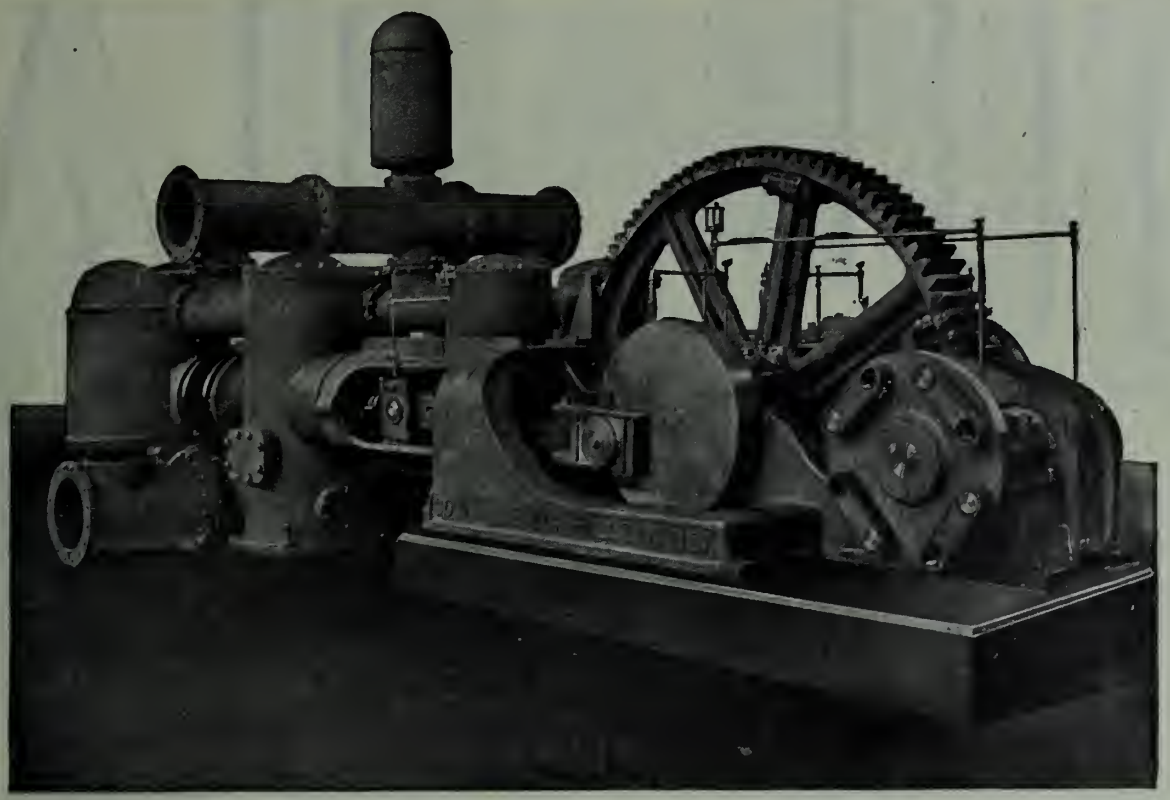

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Goulds Pumps

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Valves
Fittings
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Fairbanks-Morse and Goulds Pumps are the kind that produce results; the kind that give the maximum pumping economy.

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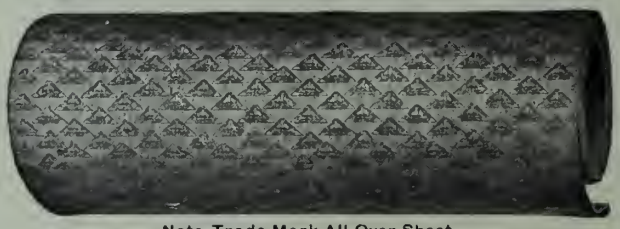

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Wherever a Permanent Gasket is Required

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WAR ECONOMY!

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Every pound of flax, rubber or asbestos put in engine stuffing box is ab-so-lute-ly wasted. This is not war economy.
It's waste of good material, waste of costly power, waste of valuable time.
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Most efficient packings made. Construction based on years of experience. Like to try them? Write!

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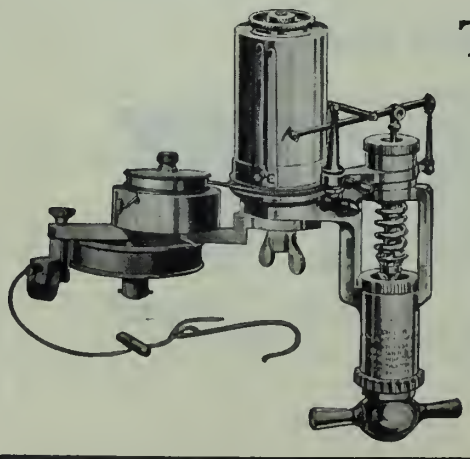

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AMERICAN IDEAL STEAM TRAP

Makes possible the LARGE CAPACITY for which these Traps are noted.

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When the plant is running at high pressure on important contracts it is unwise to take chances with a rod packing that has no established reputation for long service, even though the first cost be a trifle more than that of the shoddy imitation.

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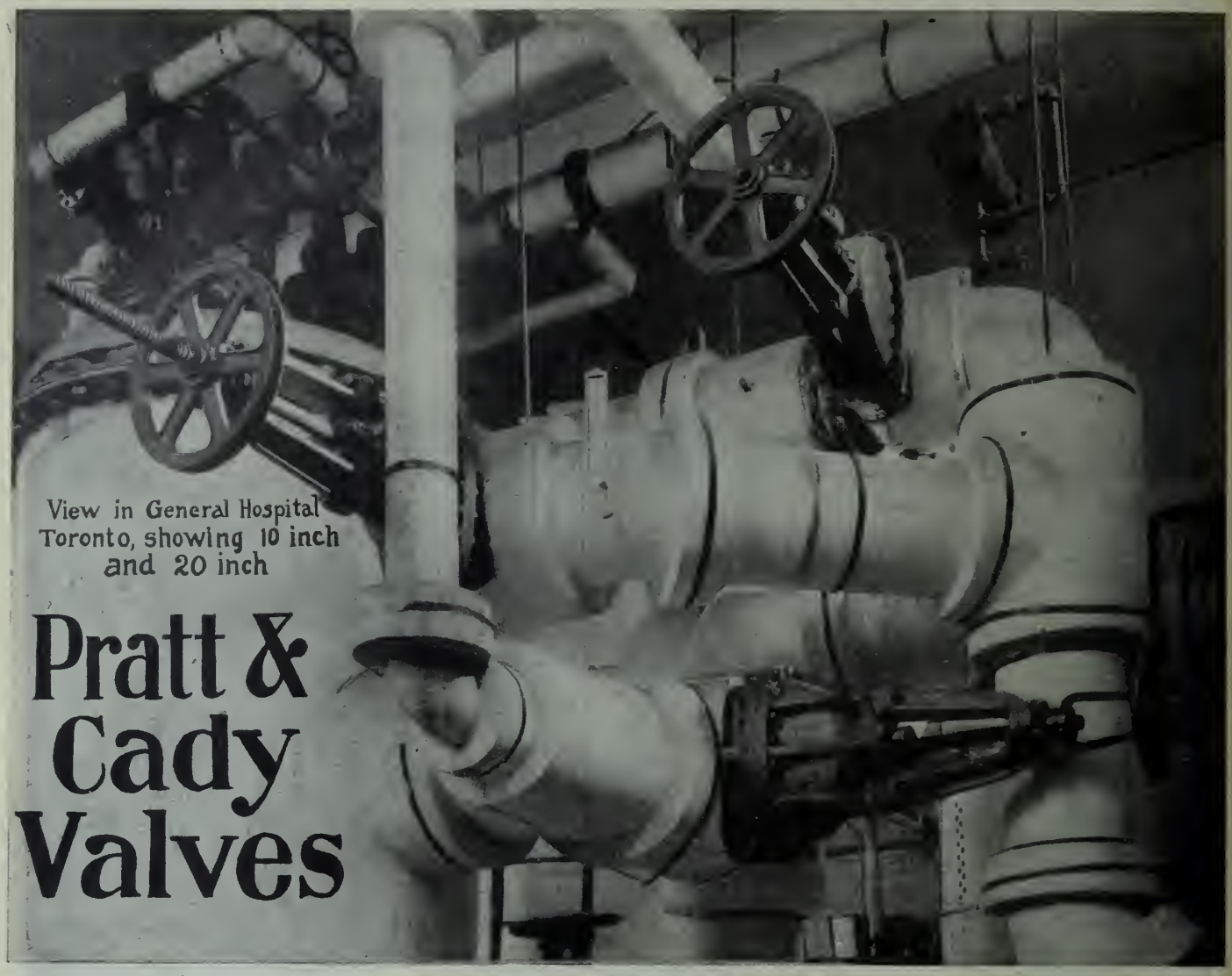

View in General Hospital Toronto, showing 10 inch and 20 inch

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The Choice of the Fittest

There is no city where the inspection of efficiency in steam appliances is more rigid than in the City of Toronto. And there is no institution in the City of Toronto more particular than the new General Hospital in the matter of superior equipment.

were selected in preference to all others in this famous institution only after a most thorough investigation of their exceptional merit.

are of reliable construction.

Seat rings are independent rings of bronze, or any special metal that best suits the requirement. They are held firmly in position, without distortion, by retaining rings of bronze, which are screwed into the body of the valve. The retaining rings can be removed easily with a wrench made for the purpose, thus allowing new seat rings to be placed in the valve without removing the valve from the line.

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Pratt & Cady Valves "Make Good" in all cases. Give them a chance to show their worth, especially in places where the service is extra heavy. Made in all styles and sizes.

Pleased to answer any questions. Full information on request. Prices quoted on receipt of specifications.

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Installations of over 1,000 hangers in a single plant bear evidence of power-saving advantages.

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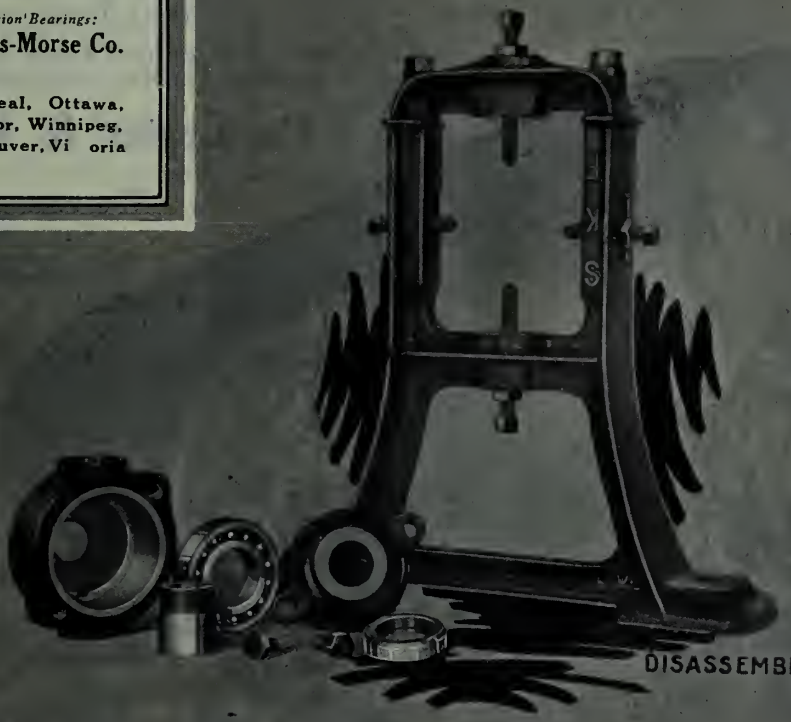

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GRATON & KNIGHT

Standardized Series

LEATHER BELTING

Tanned by us for belting use

GRATON & KNIGHT

Common Sense in the Standardization of Belting

You have standardized your signature.

You buy standardized tools, standard printing paper and a hundred other standardized things, instead of having them made to order. It is safer for you — easier and more economical.

Why don't you standardize your belting?

Consider what standardization has done for your own product; for other products you use.

Translate these advantages into terms of belting.

Analyze belt installations. You find the requirements of power transmission fall into a small number of sharply defined classes — about a dozen if you define them scientifically.

Standardized Belting offers you a standard belt that is exactly suited to each one of these classes. You adopt the one that is fitted to the needs of your own work. That is standardization—just plain common sense applied to power transmission.

There are Graton & Knight Heart, GraKnight, GraKnight Dynamo, Spartan, Neptune and other Standard Brands—all standardized on the basis of work to be done and conditions to be met.

Standardize your belts. Consult our representatives. Submit your power transmission problems to our mechanical laboratory—get *expert* advice.

Write for description of Graton & Knight Standardized Series of Leather Belts, with full information about Standardization as applied to Belting.

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Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Packings and Specialties

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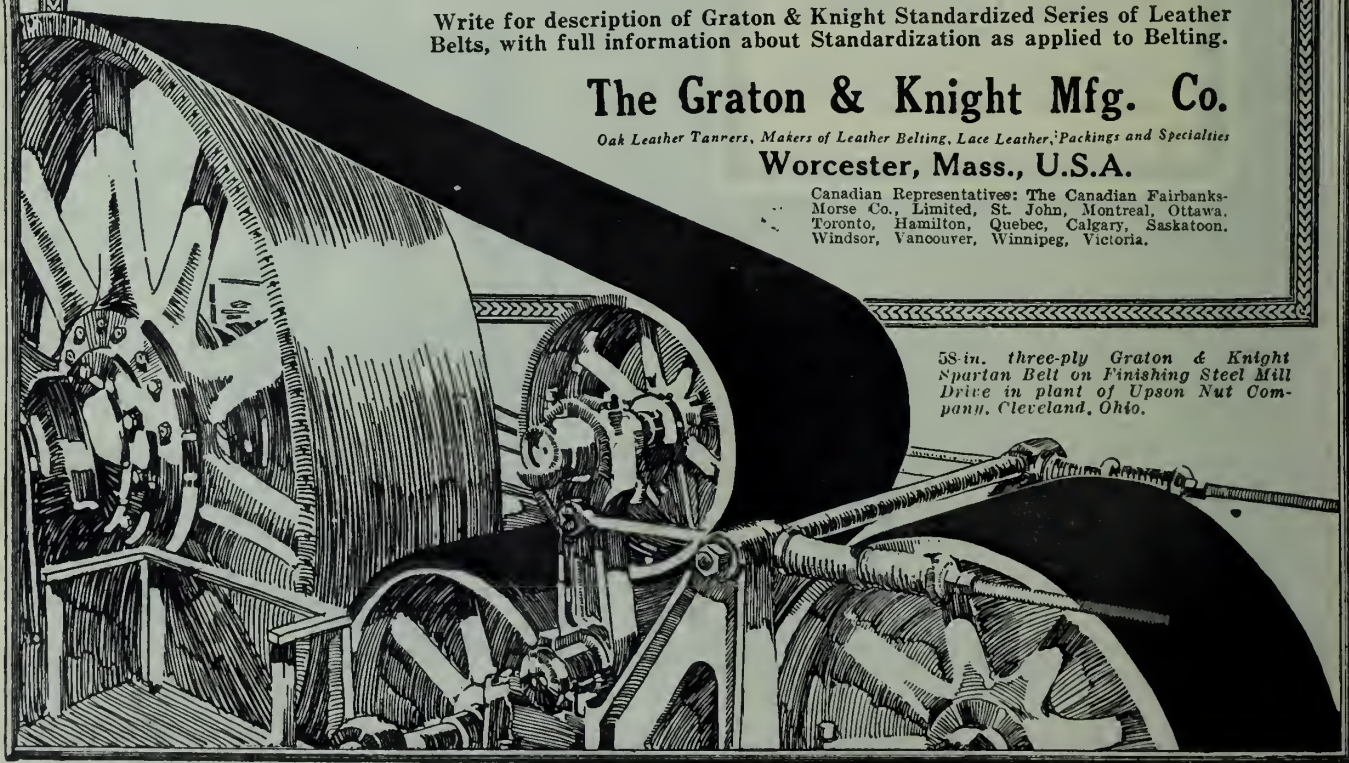

58-in. three-ply Graton & Knight Spartan Belt on Finishing Steel Mill Drive in plant of Upson Nut Company, Cleveland, Ohio.

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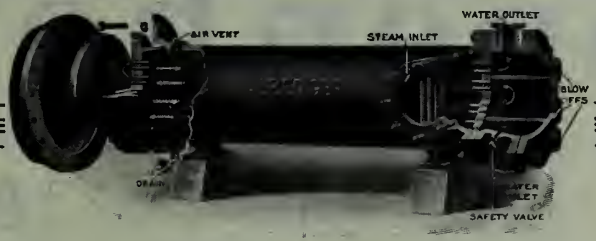

Positive Freedom From Tube Trouble

Increases heat unit by over 50% over straight tubes.
Write for complete description of its merits. It will pay you.

It is right by principle and proven by practical operation. It is superior by its achievements. Designed for boiler feed water, gravity and forced circulation heating systems, hot water service for domestic purposes, etc. Proper provision is made for expansion and contraction of the tubes and shell. Built of the highest grade materials consisting of pure copper and cast iron. Special heaters, coolers, condensers, etc., built to meet unusual conditions. A letter will receive immediate attention.

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FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

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INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

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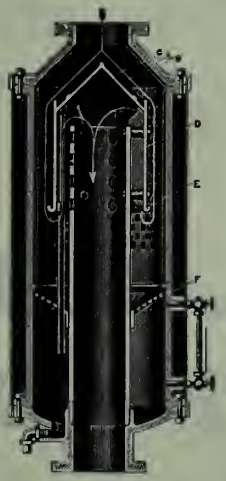
III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



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III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

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Oppenheim

John Bayne Maclean

COL. MACLEAN contributes another chapter on the war situation as he knows it, in his forceful, smashing style. These articles by Colonel Maclean are truly startling by reason of their revelations.

Germany's Secret Work in Canada

GERMANY is plotting in Canada and the United States right now. If you are curious to know just what she is doing, learn from Miss Agnes C. Laut's article in the October MACLEAN'S, "The Plot Behind the Pacifists."

THE biggest single feature ever secured by MACLEAN'S MAGAZINE is a serial story by E. Phillips Oppenheim, British author and a great writer of romantic stories.

The serial beginning in MACLEAN'S for October is "The Pawns Count," a story of the present war, dealing with the work of the secret service agents of the various belligerent countries. You can depend on its being a strong, thrilling story, told by a master of his craft.

BELAND
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The story is intimate, vivid, gripping, wholly unusual, and appears in the October MACLEAN'S.

Beating the Customs

AN article full of actual occurrences of how the public attempts to "beat" the Customs, and of how the Customs authorities beat the public. This absorbingly interesting narrative is by J. D. Ronald who, as a Customs officer, came into close touch with offenders and offences. A semi-detective article, this true story makes great reading.

Stringer, Fraser, Leacock and Hendryx

THE work of these masters of the short and long story appears in the October MACLEAN'S. Stringer's story is "The Redeemer of Waste Lands"; W. A. Fraser writes a love story, "For Catherine's Sake"; Leacock has a humorous sketch; and Hendryx continues his captivating story of the Canadian Northwest, "The Gun Brand."

MacLean's Magazine
For OCTOBER

At All News-dealers 15 cents

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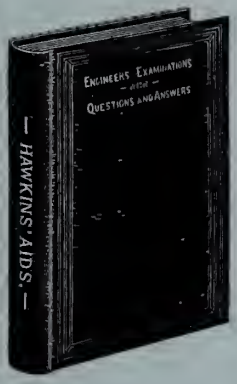

Engineers' Examinations

By N. Hawkins, M.E.

It presents in a condensed form the most approved practice in the care and management of steam boilers, engines, pumps, electrical and refrigerating machines, with examples of how to work the problems relating to the safety valve, strength of boilers and horse power of the steam engine and steam boiler.—$2.10 post paid.

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By Leland.

A reference work ou the development, advantages and disadvantages of the steam turbine; the design, selection, operation and maintenance of steam turbine plants and turbo-generators. 135 pages. Illustrated.—$1.00.

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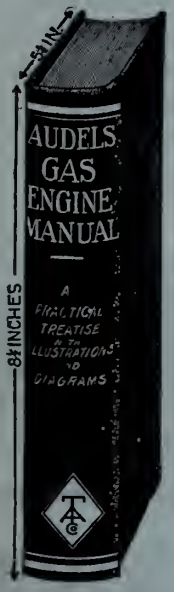

A practical treatise relating to the theory and management of gas, gasoline and oil engines, including chapters on producer gas plants, marine motors and automobile engines.—$2.00.

Hydraulic Engineering

By G. D. Hiscox.

This comprehensive book of Hydraulics written by an experienced engineer, is a practical treatise on the properties, power and resources of water for all purposes, including the measurement of streams, the flow of water in pipes or conduits; the horse-power of falling water; turbine and impact water wheels; wave motors, etc. All who are interested in Water Works Development should have a copy. 320 pages, 305 illustrations. Price $4.15 post paid.

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By L. I. Wightman, E.E.

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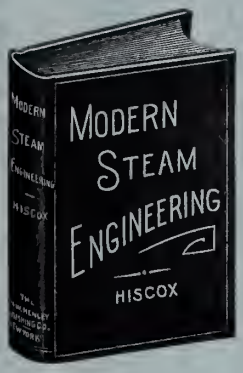

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This book has been specialiy prepared for the use of the modern steam engineer, the technical students, and all who desire the latest and most reliable information on steam and steam boilers, the machinery of power. tne steam turbine, electric power and lighting plants, etc. 450 pages. 400 detailed engravings.—$3.15 post paid.

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Boiler Accessories

By Walter S. Leland, S.B.

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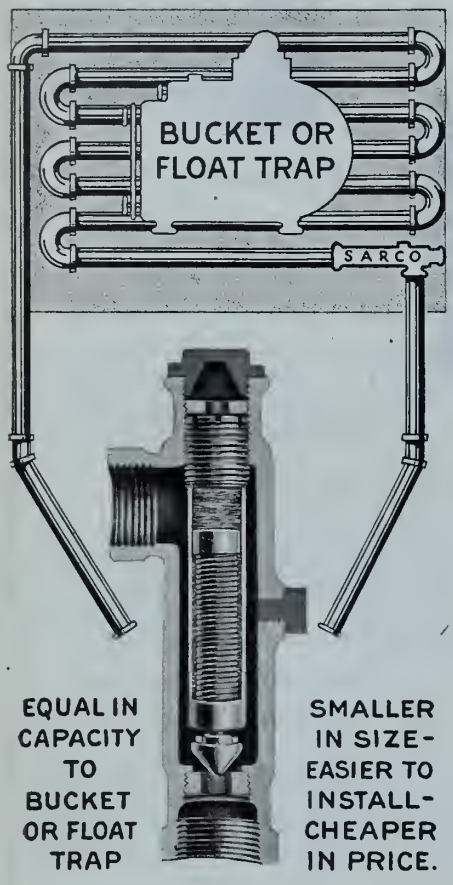

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Big Advance in Steam Trap Construction

Here's a steam facility that represents a triumph of ingenuity—used by many leading power plants and other steam users in Canada and giving matchless satisfaction—

The LONG Patent Steam Trap

Has But One Moveable Part

The Long trap may be applied to drain steam mains, jacket kettles and separators, and can also be used in drying-room systems. Can be installed in any position.

It's automatic. No possibility of freezing. Work against 1 and 200 pounds pressure. Drains 900 to 1,500 feet of one-inch pipe.

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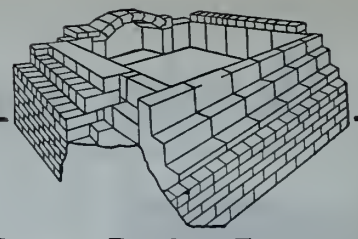

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Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

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Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box.

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Don't throw them on the scrap heap

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Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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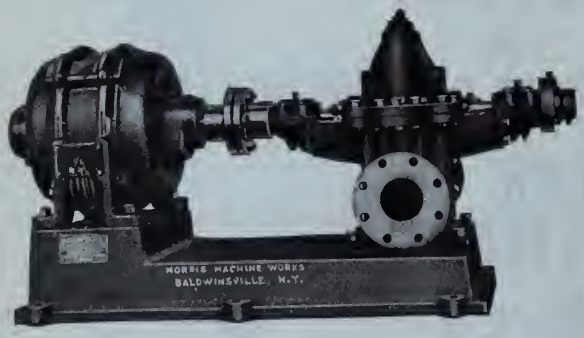
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.

American-Marsh Centrifugal Pump.

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2″ to 20″ discharge.

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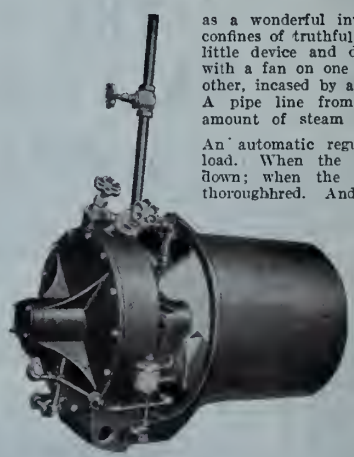
We believe we are "doing our bit" in demonstrating to manufacturers how they can effectively cut down the cost of steam production, better their combustion and increase the capacities of their boilers. In offering the

Coe Turbine Blower



as a wonderful invention, we are well within the confines of truthful advertising. It is such a simple little device and does such a big work! A shaft with a fan on one end and a steam turbine on the other, incased by a shell is about all there is to it. A pipe line from the leader supplies the small amount of steam required.

An automatic regulator adjusts the speed to the load. When the load is light, the blower slows down; when the peak comes it responds like a thoroughbred. And how it does drive the air into the fire! Clinker doesn't get a chance to form.

The gases of combustion which ordinarily pass up the chimney are held back by the draft controller, thoroughly mixed with the air and burned. Nothing gets away that is worth keeping.

Space limits prevent a complete description of the Coe Turbine Blower. Write for it and receive our special demonstration proposition. You should have it. We solicit your inquiry.

C. T. COE COMPANY

Engineers and Combustion Experts
2-14 JOHNSON ST. NEWARK, N.J., U.S.A.

CANADIAN AGENTS:
The Harland Engineering Co., Montreal, Que.

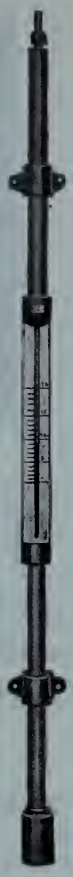
If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

UEHLING WASTE METER

COMBINED

CO_2 AND TEMPERATURE RECORDER

Record of CO_2 and stack temperature on one chart.



Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO_2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

CO_2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

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2008 Empire Building New York City

Accuracy Means Power

Accurate tools are necessary to a smooth-running plant. Make sure that the micrometers, dividers, calipers, levels and other tools in your kit are of proven accuracy. Use

Starrett Tools

You will find the Engineers' Level especially useful. It is an incline level, fixed level and plumb, all in one.
The full line of 2,100 styles and sizes of Starrett Tools is described in our free catalog.

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The World's Greatest Toolmakers

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STARRETT HIGH SPEED INDICATOR No. 104, Value $1.00 Given for two yearly paid-up subscriptions.

You May Have This Speed Indicator without Spending a Cent

if you are a subscriber to "THE POWER HOUSE." If you are not a subscriber, send in your own subscription together with two others, and the indicator you are entitled to will be mailed to you immediately.

To subscribers who send us two NEW yearly paid-up subscriptions we will send this $1.00 indicator.

"THE POWER HOUSE" is designed to give Canadian Engineers, Superintendents and Power Users all the latest and best information in the engineering field. A little work among your engineer friends and acquaintances will earn for you this handy indicator without any trouble. Try it and see how easy it will be.

PUBLISHED MONTHLY AT $1.00 PER YEAR

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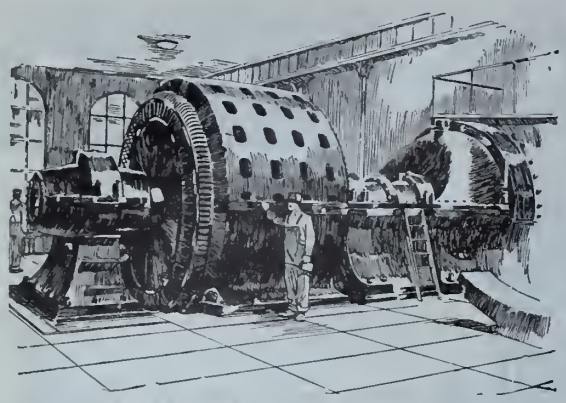

A Few Dollars Buys Increased Machinery Efficiency

HAVE you ever considered the factor spick-and-span looking machines play in quantity and quality of output, the prevention of carelessness and the improvement of shop morale?

From this standpoint alone it is a profitable investment to make your machinery new again with

R.I.W. MACHINERY ENAMEL

REMEMBER IT'S WATERPROOF
REG. U.S. PAT. OFF.

But there is definite down-on-the-books profit in protecting machines with R.I.W. Machinery Enamel.

It is impervious to oil and resistant to the action of steam or heat. One coat will increase the appraisal value of your machinery. "R.I.W." Machinery Enamel dries with a deep lustrous finish of exceptional durability. Made in any shade.

Write for literature, Dept. 59.

Manufactured in Canada by

R.I.W. DAMP-RESISTING PAINT CO.

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Technical and Scientific Paint Makers since 1848

Gerrard St. and Carlaw Ave., Toronto, Ont.

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R.I.W.
REMEMBER IT'S WATERPROOF
REG. U.S. PAT. OFF.
STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

COMMUTATOR TRUING DEVICE

Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

Jordan Bros., Inc.

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Canadian Representative :

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By Walter S. Leland, S. B.

Formerly Assistant Professor of Naval Architecture, Mass. Institute of Technology, American Society Naval Architects and Marine Engineers. 144 pp., 72 illus. Cloth binding. A treatise giving complete descriptions of the various accessories of the boiler room and engine room essential to economical operation, such as evaporators, pumps, feed-water heaters, injectors, mechanical stokers, etc., with practical instruction in their use. Price.....Postpaid $1.10

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DART UNIONS give you absolute protection against leaks. They cost you nothing for upkeep.

They cost you nothing for replacements.

They are easily connected.

They are without equal.

HERE'S THE SECRET of DART UNION Success

BRONZE TO BRONZE AT THE JOINT

When the Bronze faces of the Dart Union Pipe Couplings are drawn together, you have a joint that defies the stress of time, pressure, corrosion, vibration and expansion.

Dart Union construction portrays the most advanced idea in pipe coupling of this progressive age.

Practically everlasting—bronze faces do not deteriorate, and heavy iron parts will not stretch or pull apart.

It matters not if pipes are out of alignment in making a Dart Union Coupling—ball-shaped seat allows for an easily-made and perfectly tight connection in all cases.

Join the enthusiastic throng of Dart Union users. Order from your jobber.

Dart Union Company, Limited
TORONTO, ONTARIO

DART UNION PIPE COUPLINGS

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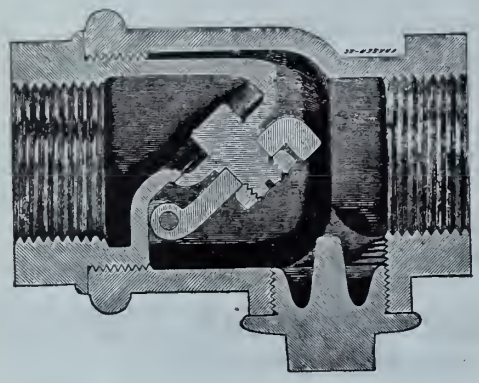
The Genuine

"McSHANE"

Straightway Swinging

CHECK VALVES

Sectional View



BRASS OR IRON

For use Upright or Horizontally

Always Ready for Inspection

Suitable for Pressures up to 250 lbs.

T. McAVITY & SONS
LIMITED

Wholesale and Retail Hardware
Brass and Iron Founders

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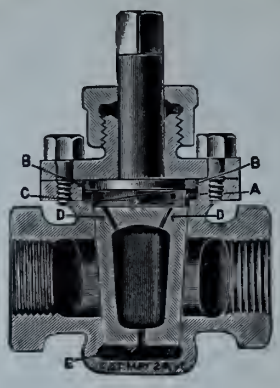
MONTREAL TORONTO WINNIPEG

Established 1824

Straight-Way
Three-way
Four-way



Quarter
Turn
Valves

HOMESTEAD
GUARANTEED VALVES

A guarantee is an expression of responsibility. We guarantee, unconditionally, Homestead Quarter-Turn Valves, both as to construction and as to service.

A glance at the cut will convince you of the simplicity of design and of the durability of construction of the Homestead Valve.

A trial order of any of our valves for your steam, gas, air, water or blow-off lines will convince you of the superior service rendered by this remarkable valve.

Just write us to-day.

HOMESTEAD VALVE MFG. CO.

Works: Homestead, Pa. Pittsburgh, Pa.

CURTIS
Engineering
Specialties

CURTIS Water Pressure Regulator

The Economy of this Curtis Water Pressure Regulator (See Illustration) lies in the fact that it greatly reduces the cost of keeping plumbing in order — This by obviating the wear and tear of water hammer or concussion in pipes.

This regulator is warranted to maintain the pressure desired, with perfect uniformity, regardless of any fluctuations of outside pressure. The workmanship and material of the Regulator cannot be excelled. Trouble from rust or clogging is entirely avoided. Delivery of water into service pipes at any desired pressure is guaranteed.

Send for special leaflet and price list to the manufacturers.

JULIAN D'ESTE COMPANY
26 Canal Street, BOSTON, MASS.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

LUNKENHEIMER
Pop Safety Valves

For all types of steam boilers.

Encased or exposed spring. Material combinations to suit all service conditions.

Bronze Pop Safety Valve. Encased Spring.

Full relieving capacity is a virtue in Lunkenheimer Pop Safety Valves. Their peculiar construction incorporating an improved "pop" mechanism, together with the large areas through the body, make this a certainty.

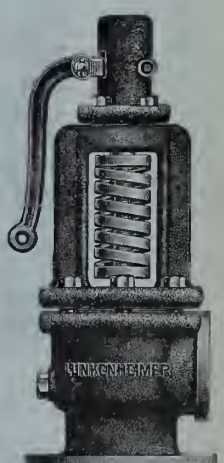
They are economical because of their durability,—which means low maintenance cost. The high-grade materials used vary for the different parts, being formulated especially for the duty each part performs. The workmanship is Lunkenheimer "Quality"—that high order which characterizes all Lunkenheimer Products.

Each valve is put through a rigid test under live steam before leaving the factory. It is set and the "pop" carefully adjusted to meet the service conditions for which the valve is intended.

Lock-key attachment is provided to guard against their being tampered with and provision is made for inserting inspector's seal.

Your local dealer can furnish them; if not, write us. Write for Booklet No. 502-DC which illustrates the complete line.

Iron Body Pop Safety Valve. Encased Spring.



Iron Body Pop Safety Valve. Exposed Spring.

THE LUNKENHEIMER CO.
"QUALITY"
Largest Manufacturers of High Grade Engineering Specialties in the World
New York Chicago CINCINNATI Boston London

4-12-4

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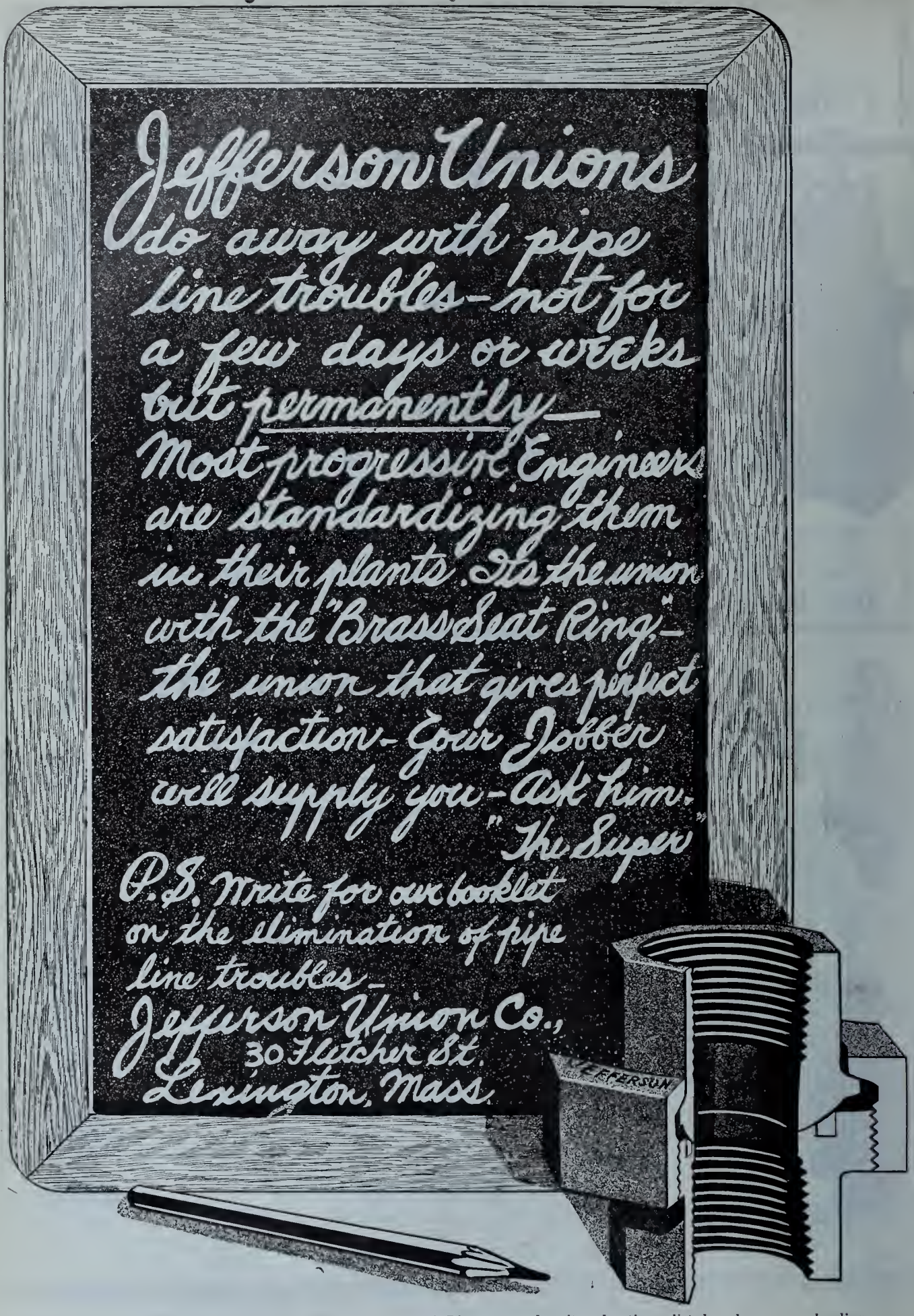
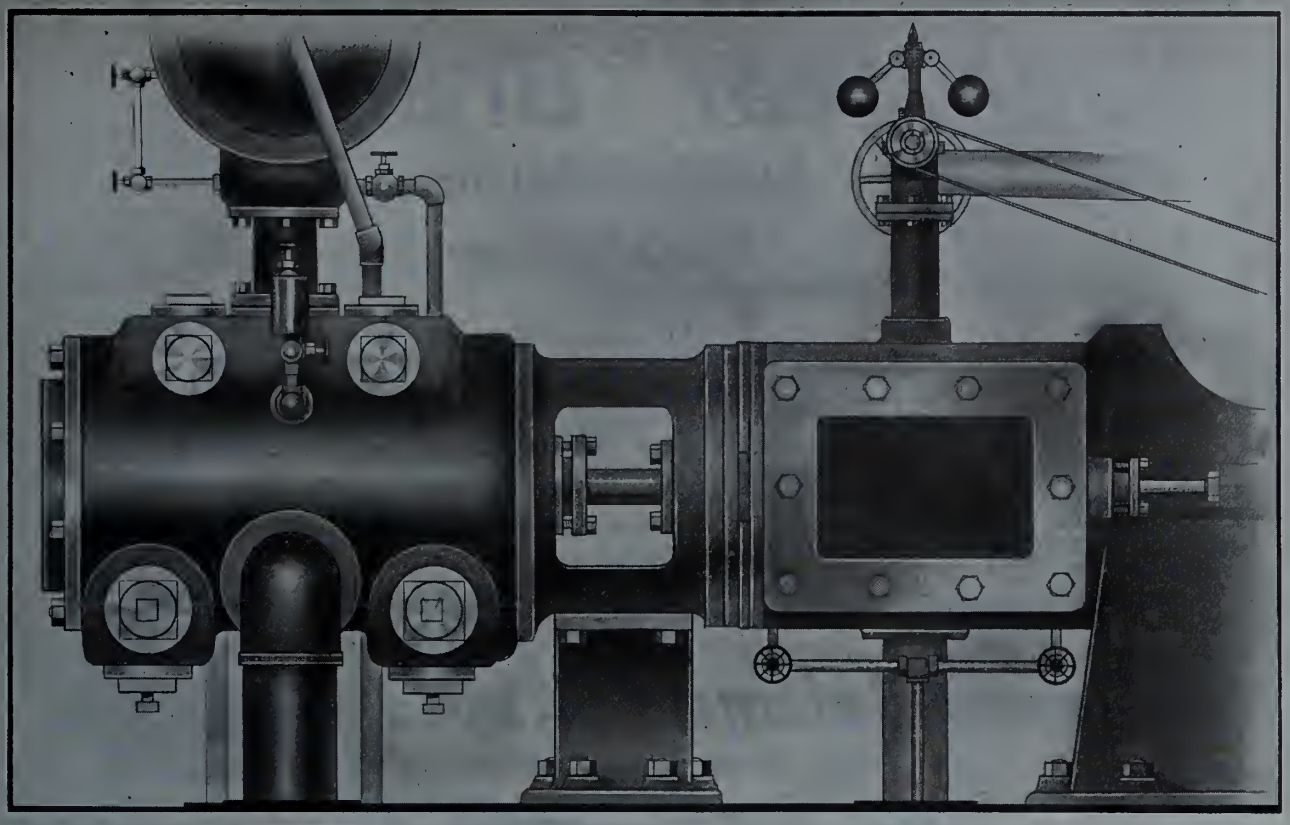
Jefferson Unions
do away with pipe line troubles—not for a few days or weeks but permanently—
Most progressive Engineers are standardizing them in their plants. It's the union with the "Brass Seat Ring"—the union that gives perfect satisfaction—Your Jobber will supply you—Ask him.
"The Super"
P.S. Write for our booklet on the elimination of pipe line troubles—
Jefferson Union Co.,
30 Fletcher St.
Lexington, Mass.





GARLOCK

Air Compressor Packings

are designed to withstand the extremely severe conditions under which air compressors usually are operated. Style No. 420 is composed of high pressure and compressor combination rings. The cushion center of the latter is covered by long fibre woven asbestos lubricated throughout with the celebrated Garlock compound. This packing does not harden in service, but retains its elasticity under the high temperatures and pressures met with in this class of work.

Garlock No. 950 Gaskets are unsurpassed for service on air compressor cylinders and flanged joints.

THE GARLOCK PACKING COMPANY, Hamilton, Ontario

BRANCHES:

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Bert. Collins

If any advertisement interests you, tear it out now and place with letters to be answered.

"Maple Leaf" Brand

Stitched Cotton Duck Belting

THE BEST FOR ALL KINDS OF BELTS

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.

Dominion Belting Co., Ltd.,
HAMILTON, CANADA

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Self-Lubricating

In Bulk

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Practically Frictionless

In Cotton Tubes

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

While You're Looking for a Ladder

that "isn't there," you can open or close a dozen of those valves that are in hard-to-get-at places (and without any risk of being thrown on your head), if you

Use The

Babbitt Adjustable Sprocket Rim

Goes right on your present valve wheel, without a bit of bother. No chance for the chain to slip. The price is low. You'll say so. Ask your dealer.

Write for illustrated Folder. It's a decidedly interesting proposition.

BABBITT STEAM SPECIALTY COMPANY

59 So. Water Street — NEW BEDFORD, MASS.

WE HAVE NO COAL

BUT

We can help you to make your present stock go farther, last longer and do more work per ton.

That will save you money and COAL. In fact it is like *finding* a little *extra* coal for you.

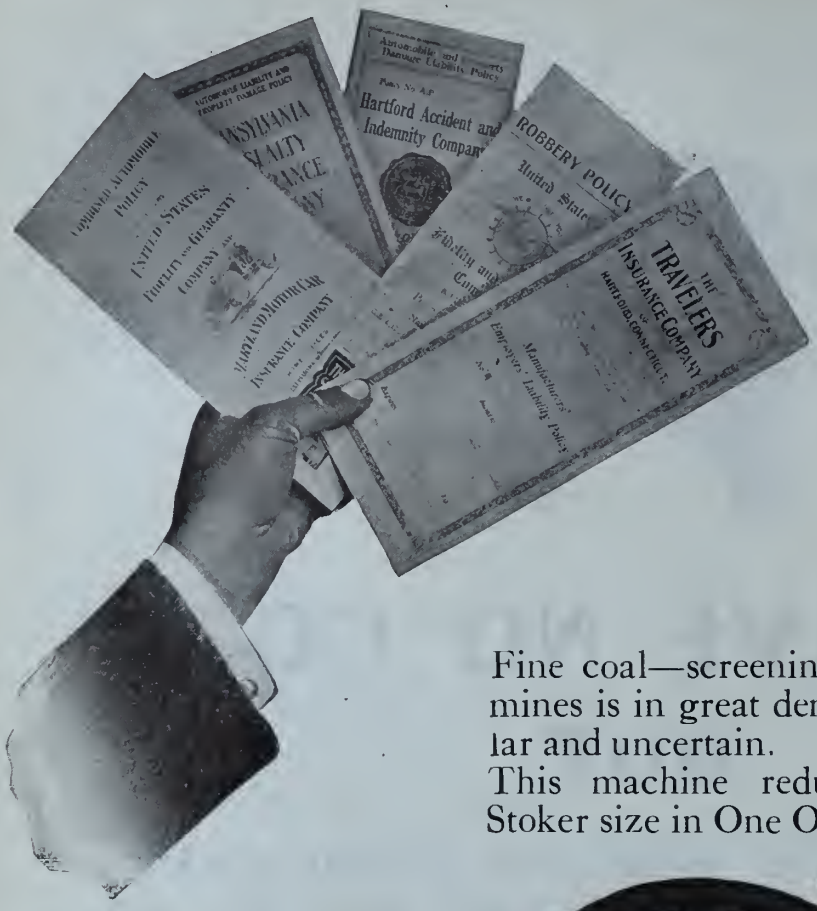
ANCHOR STEAM and HYDRAULIC PACKINGS stop leaks, save steam and water, and save coal.

Let us supply you with a little extra coal through the use of ANCHOR PACKINGS.

CANUCK SUPPLY COMPANY LIMITED

MONTREAL
TORONTO

WINNIPEG
VANCOUVER



As a Matter of Insurance Against a Shortage of Stoker Coal

install a

JEFFREY SINGLE ROLL CRUSHER

Fine coal—screenings, nut and slack—from the mines is in great demand. Deliveries are irregular and uncertain.

This machine reduces Run-of-Mine coal to Stoker size in One Operation.

The recognized standard wherever Coal Crushers are used.

Special Features

- Easy to install.
- Occupies small space.
- Has large range of capacities.
- Starts under full load.
- Built for hard service.
- All parts easily accessible.
- Has renewable wearing parts.
- Efficient safety device against iron.

Bulletin No. 141 tells all about this machine—what it can do—and how it can be installed in connection with Coal Handling Equipment.

Send for your copy.

The Jeffrey Manufacturing Co.

Canadian Branch and Warerooms

MONTREAL

D. K. McLaren's

GENUINE OAK

GENUINE OAK

Genuine British-Oak Tanned

BELTING

Banishes All Belt Troubles

You get better results all through your plant when you use good belting, like *D. K. McLaren's* celebrated British-Oak Tanned Belting.

Their steady grip and flexibility give uniform and full speed, even when comparatively loose. *Least slippage! Least breakage! Most power!*

Hides of the choicest steers, long experience and the Genuine British-Oak Tanning Process stand behind every inch of our belting.

D·K·McLAREN LIMITED

Many of Canada's largest industrial plants (firms that want the best of everything) are steady users of our belting. Try it.

HEAD OFFICE AND FACTORY

351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

TORONTO, ONT.
194 King St. West

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VANCOUVER, B. C.
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TRADE MARK

MAGNOLIA ANTIFRICTION METAL

TRADE MARK

FOR CROSSHEAD BEARINGS

Beloit, Wis.,
Oct. 11, 1916.

Magnolia Metal Company,
New York City.

Gentlemen:

I am using Magnolia Metal in all bearings that I re-babbitt.

In one place in particular is crosshead bearings of Corliss engines. The original crosshead bearings were brass, running on steel pins, and when they were down I bored out the brasses, leaving a rib on the ends, drilled holes for anchoring and lined the brasses with Magnolia Metal with success.

You may use my letter if you so desire, I remain,

Yours very truly,
E. A. McKEE,
953 Moore Street,
Engineer for P. B. Yates Machine Company.

PRACTICAL ENGINEER POCKET BOOK:
Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY
MAGNOLIA METAL CO.
OFFICE AND FACTORY:
225 St. Ambroise St. MONTREAL

Speed Up—

IN War Times you should get all the speed out of your machines possible.

You can do this by using BOND Hangers. From the day you put a BOND Hanger on the job it starts saving your oil, your power, and your patience.

It is an investment that yields a steady return with every revolution of your shafting.

The sturdy, braced construction makes for smooth running without vibration. Its design permits full accessibility for adjustments or erection.

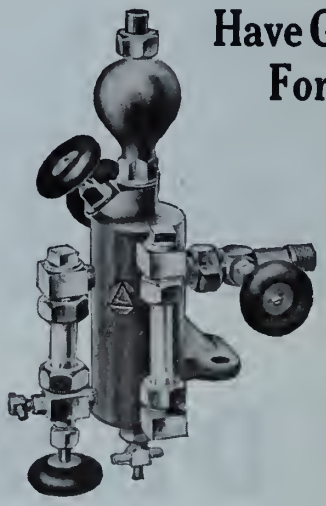
The Bond Hanger Book tells about everything we make in the line of power appliances.

Your files are not complete without it.

CANADIAN BOND HANGER & COUPLING CO.
Limited
ALEXANDRIA ONTARIO

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

Insurance

A STEAM joint blown out means loss — loss of production, loss of money.

And many times it means injury to employees — together with costly damage suits.

A cheap sheet packing of the ordinary type can easily cause any or all of these.

You should buy a dependable quality of sheet packing.

Goodyearite has won its supremacy in the industrial world on its merits.

Made up of the longest fibres of the best rock asbestos obtainable and manufactured by a special process, it has more asbestos and less filler than any sheet on the market.

Goodyearite is safe for high pressure and superheat steam, strong and dilute solutions of acids, alkalies, general industrial chemicals, gas and gasoline.

Tested under 750° of heat, Goodyear gaskets were in usable condition when removed.

Goodyearite is stocked by mill supply and hardware dealers, and by Goodyear branches. It comes in sheets 36″ x 36″ and in thickness of 1/32″, 1/16″, 3/32″ and 1/8″. Because its weight per square yard is light, Goodyearite is economical as well as safe.

The Goodyear Tire & Rubber Co. of Canada, Limited

TORONTO, ONT.

Branches at : Vancouver, Edmonton, Calgary, Regina, Winnipeg, Hamilton, London, Toronto, Ottawa, Montreal, St. John, Halifax

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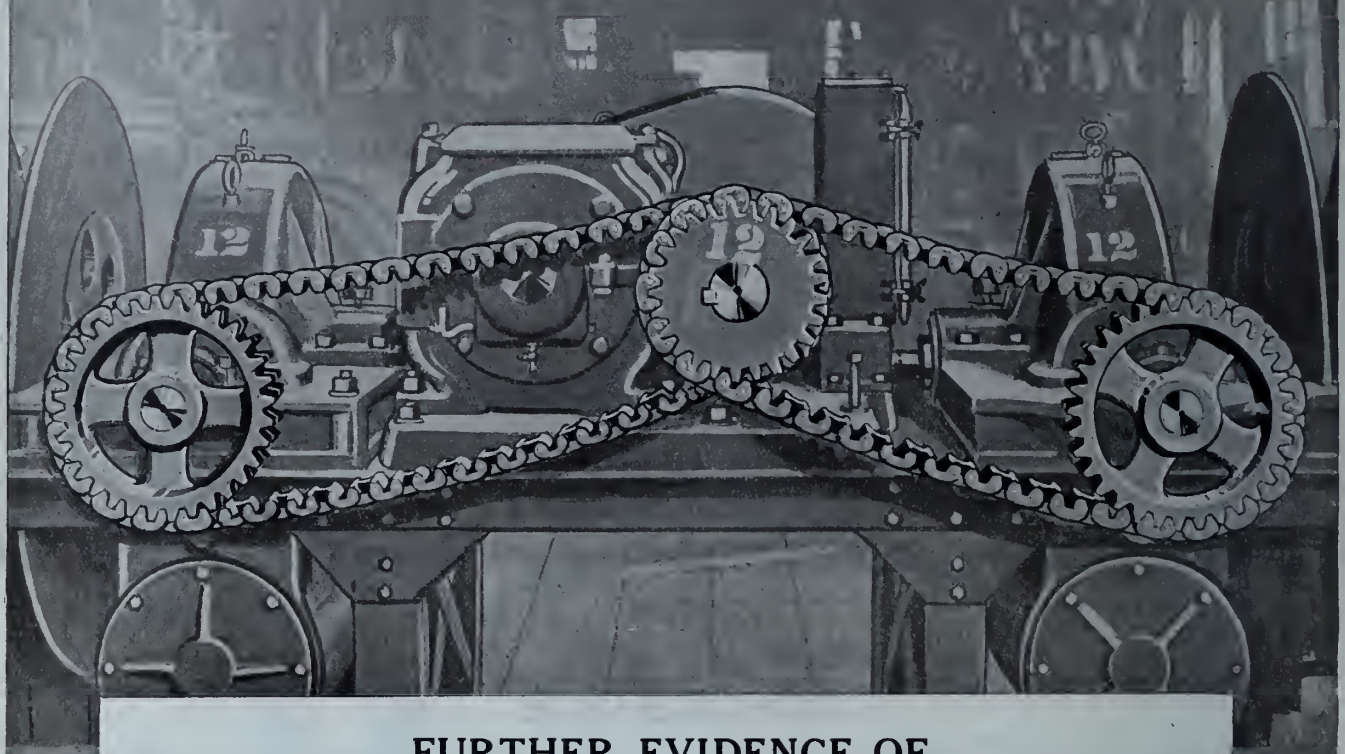
MORSE SILENT CHAINS OPERATE PANAMA CANAL EMERGENCY GATES



FURTHER EVIDENCE OF

Morse Dependability

THE UNITED STATES GOVERNMENT, before selecting the form of POWER TRANSMISSION which should operate the Emergency Gates of the Panama Canal Locks, made a comparative investigation of all the large manufacturers of Silent Chains, putting their products through searching tests of STRENGTH and ADAPTABILITY.

MORSE SILENT CHAINS showed a much higher tensile strength than any other make, and were selected as the chains which could be depended upon in emergencies. Accordingly, the Otis Elevator Co., which installed the 36 Control Units was instructed to operate them through MORSE SILENT CHAINS. One of the units is pictured above.

Write us for still further evidence of the Government's confidence in "MORSE." Government tests are worth investigating.

MORSE CHAIN CO., - Ithaca, New York

Largest manufacturers of silent chains in the world.

MORSE CHAIN COMPANY ITHACA, NEW YORK

MORSE CHAIN COMPANY ITHACA, NEW YORK

ALBANY GREASE

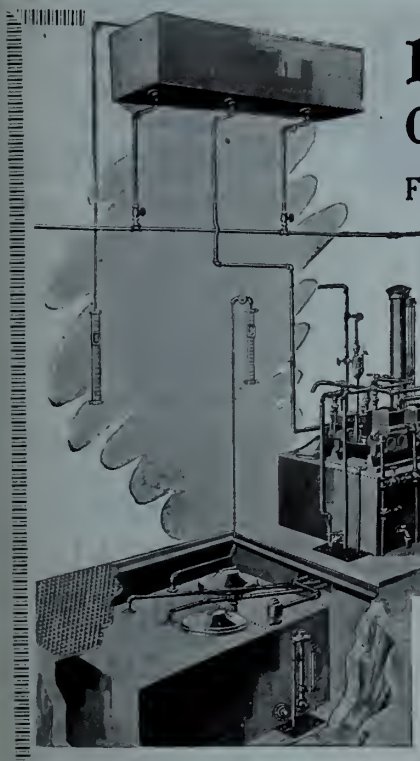
ALBANY LUBRICATING COMPOUND EZR IC 0 30 50

Improved Bearings

Are all the bearings in your plant running cool and easy? Are they bound up by friction, consuming wastefully power that should be used in useful work? If so, improve this condition by using Albany Grease on every bearing in your plant—always. Albany Grease is efficient and at the same time very economical. It keeps bearings running cool and eliminates friction and can be used in any kind of grease cup. Send for a trial quantity of Albany Grease and an Albany Cup—now.

Your Dealer Sells Albany Grease, If Not Order Direct

Albany Lubricating Co.
708-10 Washington St., New York
ESTABLISHED 1868



BOWSER
ESTABLISHED 1885

Oil Circulating and FILTERING SYSTEMS

Increase the capacity of the power plant; keep it at a high standard of efficiency, by supplying every point of friction with a constant stream of pure—cool—lubricating oil. After use, oil is returned to filter, purified and again sent out to points of use. No oil is lost.

Bowser systems are built for any capacity, any requirement. Tell us your needs.

S. F. Bowser & Co., Inc.
Sales Offices In All Centers — Toronto, Ont. — Representatives Everywhere

"Good Morning, Jim."

"Good morning, Mr. Hawley."

The new Superintendent had stopped in the engine room, where Jim, the Engineer, was getting everything ready for a flying start. The company had a big Government contract, and was running twenty-four hours a day, six days a week, three shifts and five engines, four of which were running.

"What are you doing with No. 5, Jim?" asked Mr. Hawley. "Got some belt trouble?"

"No sir. While she's shut down I've had George paint the back of that new belt."

"Paint it?"

"Yes sir, with CLING-SURFACE. You see, all belts get pretty dry, and it used to bother me a lot until I got this CLING-SURFACE. Well, the company advises painting the back of a good clean belt with CLING-SURFACE, so it will soak it up quicker and prevent cracking, and I gave it a trial. That's the new belt—all the others were painted about a year ago."

"How do they work?"

"Fine! There's the belt on No. 1. I had that painted last year, when Mr. Hodges was Superintendent, and put the CLING-SURFACE on just warm enough to use. You'd be surprised how quick the stuff got into the leather, and since then it's just as clean and pliable as a kid glove."

"Do they slip?"

"Not a bit. George puts a little CLING-SURFACE on the belt face with a stick about once or twice a week—just as fast as they will take it up, and the belts always pick up the load and hold it. And I haven't had to take-up any of them since this treatment was started a year ago."

* * *

It is a patriotic duty to conserve your present equipment. Instead of buying new belts, treat your present drives with CLING-SURFACE, and make them last longer and work better for you.

Prove it at our expense. Order a 25 or 50-pound can on trial—60 days, and with these results guaranteed before you pay.

Remember, use CLING-SURFACE and you won't need belt dressings.

Cling-Surface Co
1057 Niagara Street
Buffalo New York
U S A

If any advertisement interests you, tear it out now and place with letters to be answered.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penaltiea set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

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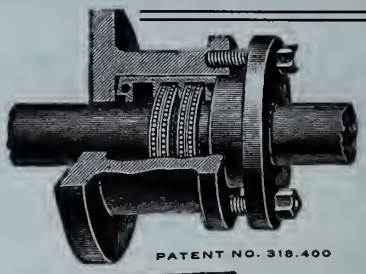

PATENT NO. 318,400

PAT. NO.	600,899	PAT. NO.	829,116
" "	634,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	899,066
" "	775,193	" "	905,103
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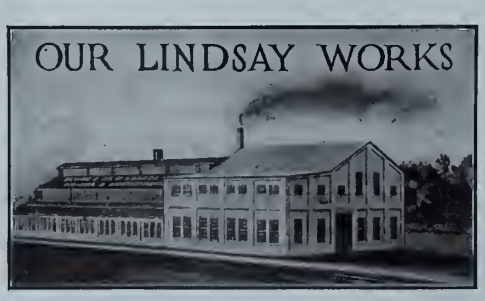

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(b) To hold meetings for discussing theoretical and practical matters pertaining to its calling;

(c) To examine stationary engineers and firemen as to their proficiency, and to grant graded certificates of ability to its members, and to be a medium through which steam and electric users may be supplied with good and reliable engineers, and to grant relief to its members in cases of sickness and distress."

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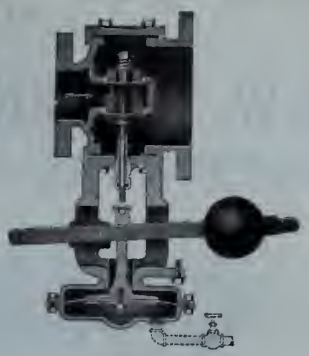

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Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID.
Minister of Public Works and Highways

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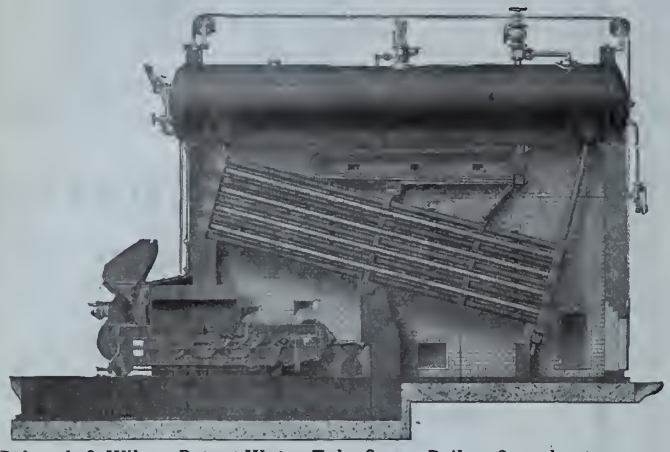

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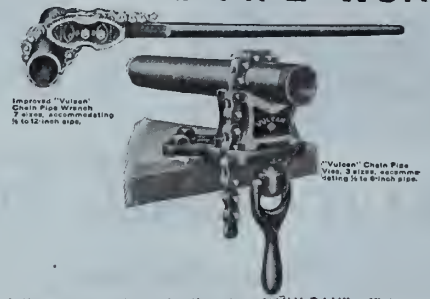

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Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE, COMPOUND AND TRIPLE EXPANSION
Canadian Griscom-Russell Co., Ltd., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.
Kerr Engine Co., Walkerville.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
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ENGINEERING BOOKS
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Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Jas Morrison Brass Mfg. Co., Toronto.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Watson & McDaniel Co., Philadelphia.

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Alberger Heater Co., Buffalo, N.Y.
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

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Can Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green Fuel Economizer Co., New York, N.Y.
Sturtevant Co. of Canada, Ltd., B. F., Galt, Ont.

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Babcock & Wilcox, Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
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Stewart Heater Co., Buffalo, N.Y.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Stewart Heater Co., Buffalo, N.Y.

FEED WATER REGULATORS
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Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.
"S-C" Regulator Co., Fostoria, Ohio.

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Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works, Montreal.

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Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Manufacturing Co., York, Pa.

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Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

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Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
McAvity, T. & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Toronto.
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Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.

FLOORING COMPOSITION
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Babcock & Wilcox, Ltd., Montreal.
Liberty Mfg. Co., Pittsburg, Pa.
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Uehling Instrument Co., New York.
Precision Instrument Co., Detroit, Mich.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
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MacKinnon, Holmes & Co., Sherbrooke, Que.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md

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Graton & Knight Mfg. Co., Montreal.

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Gates, J. W., Montreal, P.Q.

FURNACES, SMOKELESS
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Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.

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Economy Fuse & Mfg. Co. of Canada, Montreal.

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Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

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Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

GAS COLLECTORS
Precision Instrument Co., Detroit, Mich.

GAS PRODUCER PLANTS
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Laurie & Lamb, Montreal.

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Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
S-C Regulator Co., Fostoria, Ohio.
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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Babcock & Wilcox, Montreal.
Foxboro Company, Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T. & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
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C. T. Coe Co., 10 Johnson St., Newark, N.J.
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Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

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Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Griscom-Russell Co., Ltd., Montreal.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal, Que.

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Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal
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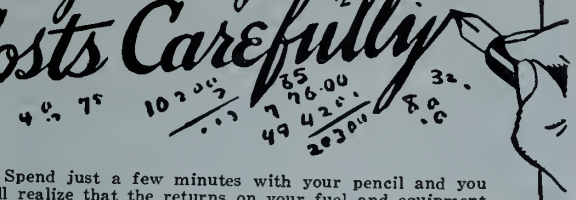

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Not only will a "Detroit" System pay for itself in a short time, but will continue to save hundreds of dollars a year right in your boiler room by saving fuel.

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Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
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Scaife & Sons, Wm. B., Pittsburgh, Pa.
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Linde Canadian Refrigeration Co., Montreal.
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Penberthy Injector Co., Windsor, Ont.

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Beveridge Paper Co., Ltd., Montreal, Que.
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INSULATORS
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Can. H. W. Johns-Manville Co., Toronto, Ont.
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LAMPS, NITRO
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LAMPS, TUNGSTEN AND NITRO
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Can. H. W. Johns-Manville Co., Toronto, Ont.

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Canadian Economic Lubricant Co., Montreal.
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Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
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Darling Bros., Montreal.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
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Penberthy Injector Co., Windsor, Ont.

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Jones Underfeed Stoker Co., Toronto.
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Waterous Engine Works Co., Brantford.

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Penberthy Injector Co., Windsor, Ont.

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OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

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Can. B. K. Morton Co., Toronto, Montreal.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
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Can. Asbestos Co., Montreal, Que.
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Can. B. K. Morton Co., Montreal, Que.
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Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Peerless Rubber Mfg. Co., New York, N.Y.
Steel Mill Packing Co., Windsor, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

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Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Durabla Mfg. Co., New York, N.Y.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.

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Can. B. K. Morton Co., Montreal, Que.
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Canuck Supply Co., Ltd., Montreal, Que.
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Goodyear Tire & Rubber Co., Toronto.
Greene, Tweed & Co., New York.
Steel Mill Packing Co., Windsor, Ont.

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Canuck Supply Co., Ltd., Moutreal, Que.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd, Toronto, Ont.

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MacKinnon, Holmes & Co., Sherbrooke, Que.

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Waterous Engine Works Co., Brantford.

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PIPE STEEL
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PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

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Lunkenheimer Co., Cincinnati, O.
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York Mfg. Co., York, Pa.

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Waterous Engine Works Co., Brantford.

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Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
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Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Canada.
Laurie & Lamb, Montreal.
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Jenckes Machine Co., Sherbrooke.
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The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
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Waterous Engine Works Co., Brantford.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Canadian Fairbanks-Morse Co., Ltd., Montreal.
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Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

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Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

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American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Bawden Machine Co., Ltd., Toronto.
Laurie & Lamb, Montreal.
McAvity, T. & Sons, Ltd., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

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Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
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American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.

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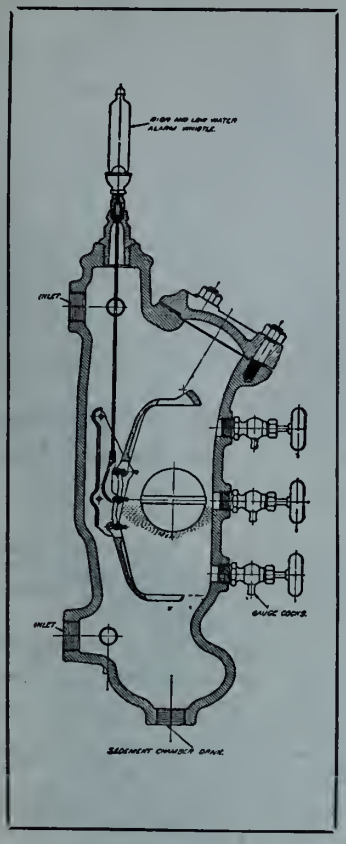
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.



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It is built with the inherent qualities that characterize all Anderson goods. An inquiry will receive our prompt attention.

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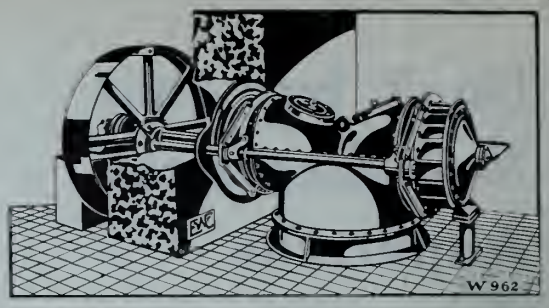

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A 173

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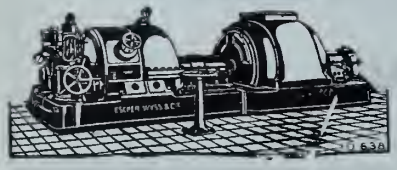

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62-17

INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 75
Alberger Heater Co. 55
American Steam Gauge & Valve Mfg. Co. 50
American Steam Pump Co.... 60
Anderson Co., V. D..... 83
Armstrong Cork Insulation Co. 11
A.S.K. Chemical Co. 58

B

Babbitt Steam Specialty Co.... 68
Babcock & Wilcox 78
Bawden Machine Co., Ltd..... 6
Bennis & Co., Ltd., Ed..... 4
Beveridge Paper Co. 86
Boiler Inspection Dept..... 77
Boving Hydraulic & Eng. Co.. 76
Bowser, S. F., & Co., Inc..... 75

C

Can. Assoc. Stationary Engrs.. 77
Can. Bond Hanger & Coupling Co. 72
Can. B. K. Morton Co..... 8
Can. Detroit Lub. Co. 72
Can. Economic Lubricant Co... 59
Can. Fairbanks-Morse Co. 49
Can. Laco-Philips Co. 85
Can. H. W. Johns-Manville Co., Ltd. 9
Can. Morehead Mfg. Co. 81
Can. Sirocco Co. 81
Can. S K F Co. 53
Canuck Supply Co., Ltd..... 69
Chaplin-Fulton Co. 83
Cling-Surface Co. 75
Coe Co., C. T. 60
Cole, Geo. W. 48
Coppus Eng. & Equip. Co..... 6

D

Darling Bros. 59
Dart Union Co. 63

PAGE

Davis Regulator Co. 83
Dearborn Chemical Co. 13
D'Este Co., Julian 64
Direct Separator Co. 55
Dixon Crucible Co.. Jos..... 48
Dominion Belting Co. 68
Dominion Coal Co. 76
Durabla Mfg. Co. 50

E

Economy Fuse & Mfg. Co. of Canada 4
Elliott Co. 45
Escher Wyss & Co. 88

F

Federal Engineering Co. 81
Foxboro Co. 87
Francis, Walter J., & Co..... 48
Frick Co. 11

G

Galt Foundry Co. 5
Garlock Packing Co. 67
Garth Co. 76
Gates, John W. 58
Goldie & McCulloch Co. 18
Goodyear Tire & Rubber Co.... 73
Graton & Knight Mfg. Co..... 54
Greene, Tweed & Co. 51

H

Holmes Metallic Packing Co... 76
Homestead Valve Mfg. Co..... 64
Hoyt Metal Co. 2

I

Inglis Co., John..Inside back cov

J

Jamison Cold Storage Door Co
Jefferson Union Co. .....

PAGE

Jeffrey Mfg. Co. 70
Jenckes Machine Co. 2
Jenkins Bros. 15
Jones Underfeed Stoker Co., Ltd. 4
Jordan Bros., Inc. 62

K

Kellogg & Co., E. H..... 48
Kerr Engine Co. 65

L

Ladd Co., The Geo. T. 76
Laurie & Lamb 14
Leitch Co., The Arthur S..... 77
Linde Canadian Refrigeration Works Co. 10
Long, J. T. 58
Lunkenheimer Co. 65

M

MacGovern & Co. 87
MacKinnon, Holmes & Co. 48
MacLean's Magazine 56
Magnolia Metal Co. 72
Martell Packings Co. 50
Mason Regulator Co. 6
Mason Regulator & Eng. Co., Ltd. 7
McAvity & Sons T
McDoug
Wor
McG
Mc
M

PAGE

P

Peacock Brothers 87
Peerless Rubber Co. .....
Inside front cover
Penberthy Injector Co., Ltd...
Outside front cover
Pennsylvania Flexible Metallic Tubing Co. 55
Pratt & Cady Co. 52

S

Sarco Co., Inc. 58
"S-C" Regulator Co., The 81
Scaife, Wm. B., & Sons Co.... 86
Schaeffer & Budenberg Mfg. Co. 6
Shell-Bar, Boico Supply, Ltd... 3
Smart-Turner Mach. Co. 77
Starrett, L. S., Co. 61
Steel Mill Packing Co. 68
Storey Pump & Equipment Co. 60
Sturtevant Co. of Canada, B. F. 47

T

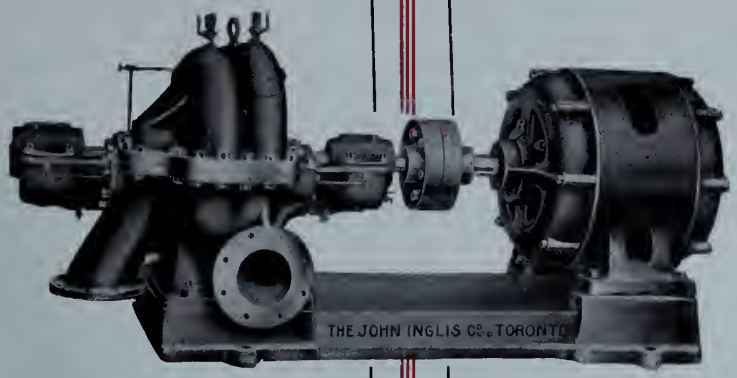
Taylor Instrument Co..... 87
Thomas Grate Bar Co. 5
Trimont Manufacturing Co..... 78
Toch Bros. 62

U

lling Instrument Co. 61

V

10



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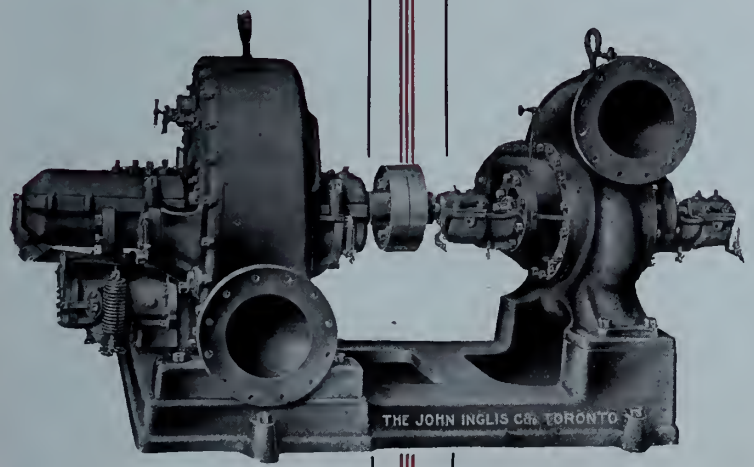

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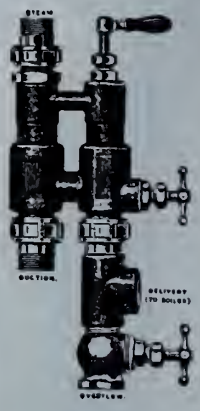

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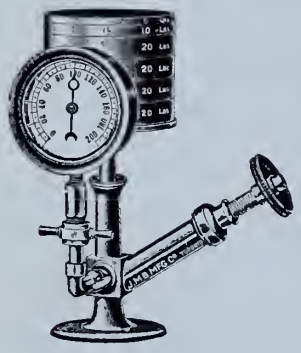

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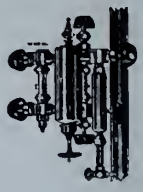

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Vol X—No. 10 Publication Office, Toronto—October, 1917 Published Monthly $1.00 per Year.

PENBERTHY

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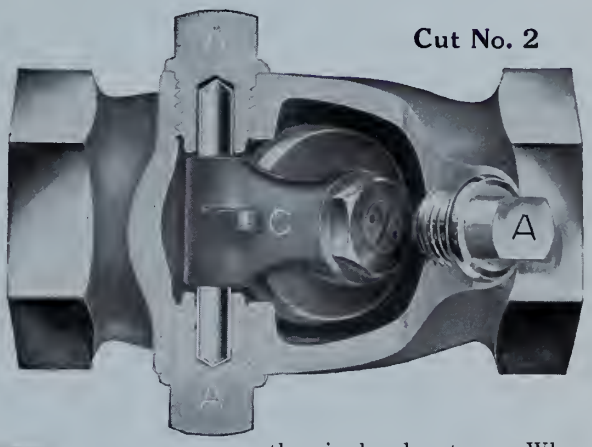
REGRINDING SWING-CHECK VALVES

The Check Superior

Cut No. 1

Cut No. 2



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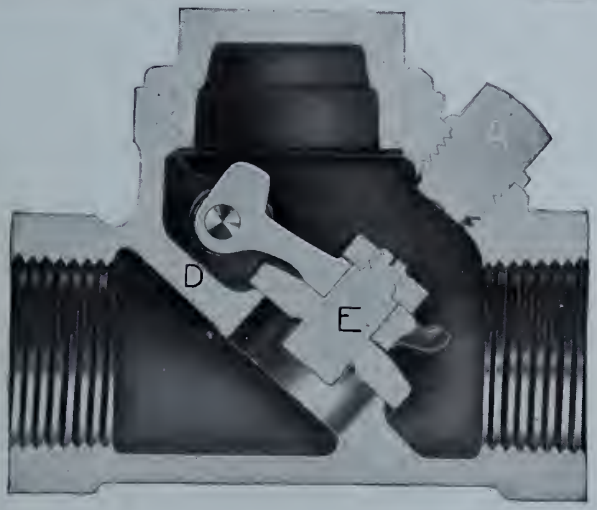

Cut No. 1

Shows an external view of the Penberthy Swing Check Valve and illustrates location of top and side plugs, which features are described in following description. The above illustration also gives a good idea of the symmetrical design of this superior check.

Cut No. 2

Shows a sectional top view. The Penberthy Swing Check is what is termed a double plug valve. (Note the two side plugs lettered A). These plugs act as bearings for the disc carrier pin. Should the movement of the pin cause the plugs to become worn, they can be replaced, saving the body and making the check as good as new. The double plug type check has another advantage over the single plug type. When mounted in a wall pipe it is always possible to take the valve apart, as one plug is always accessible. The top plug (also letter A) is also removable for insertion of screw-driver when regrinding is necessary. This feature eliminates the necessity of removing the valve from pipe line when repairs are necessary.

Cut No. 3

Shows sectional side view and illustrates to advantage the liberal thickness of metal in diaphragm. (See letter D), also the even distribution of metal throughout. All Genuine Penberthy Checks bear our trade-mark and the registered pressure 200 lbs. is also cast on each.

For Superior Checks specify Penberthy.

PENBERTHY INJECTOR CO., Limited, Windsor, Ontario

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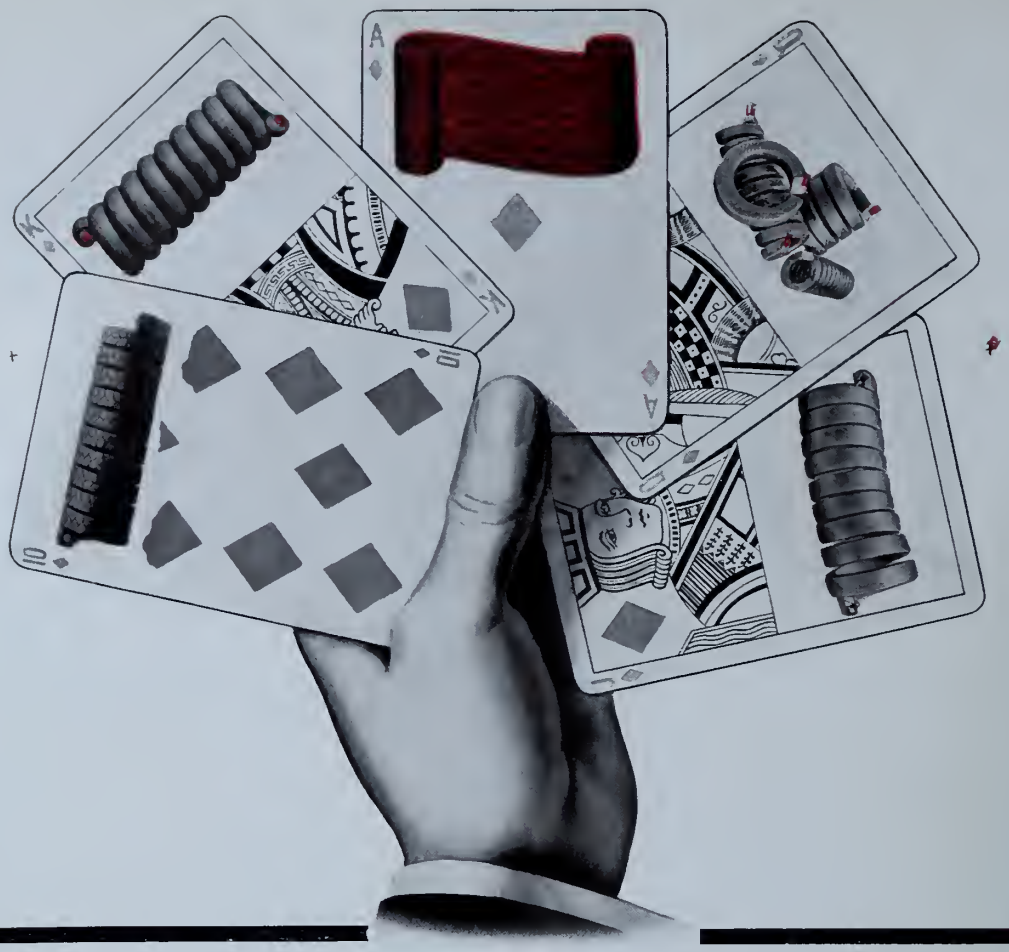

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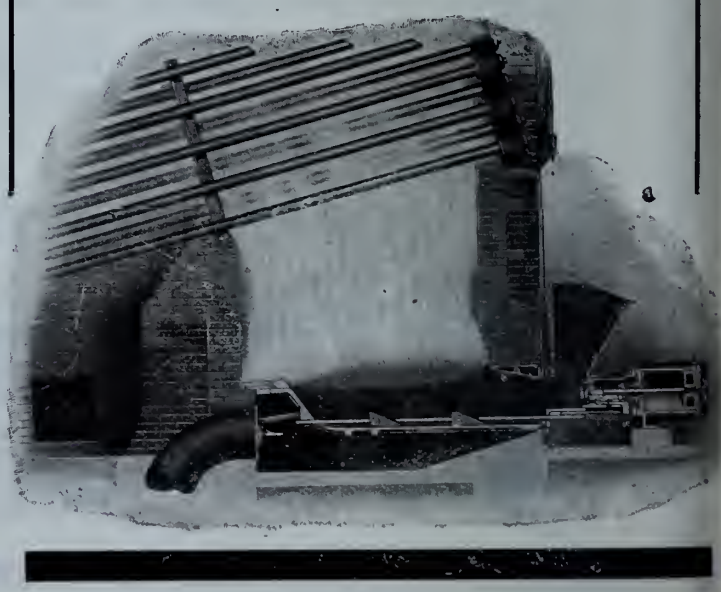

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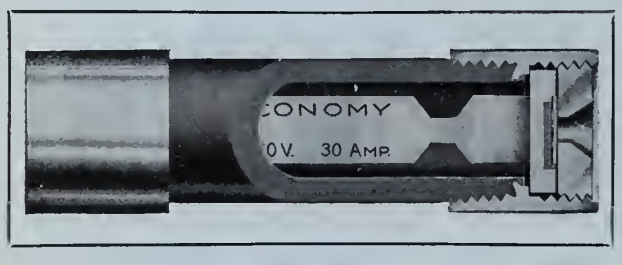

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Mason No. 55 Pump Pressure Regulator

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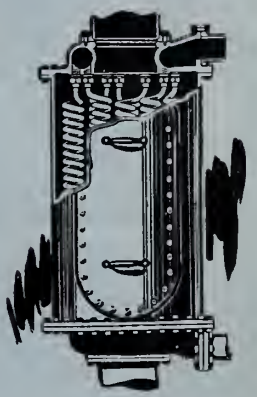

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Bulletins and full information gladly furnished.

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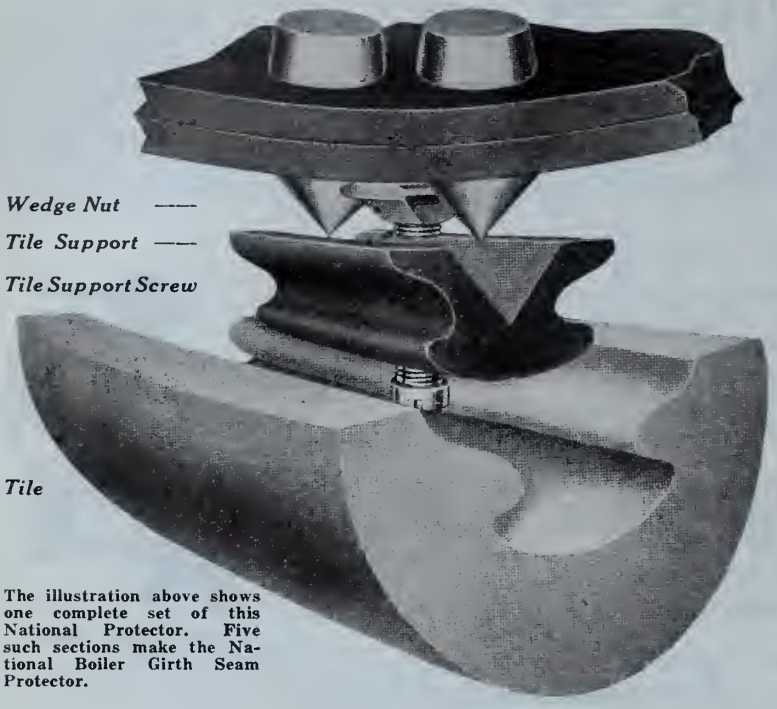
The National Boiler Girth Seam Protector

Patented U.S.A. October 25th, 1916 **Foreign Patents Applied** **Patented Canada May 29th, 1917**



The illustration above shows one complete set of this National Protector. Five such sections make the National Boiler Girth Seam Protector.

The Only Perfected Device which prevents

Fire Cracks and Leaks on all Steam Boilers

It is needless to say that the manufacturers of Horizontal Boilers have been charged with the failure of the seam, which has not been any fault of theirs, for they have been directing their attention toward a remedy; and the only solution seemed to be a single shell on the bottom, but that construction has been a failure.

If you are now using H. T. Boilers, you are aware that the seam is a great deal of trouble, owing to crystallization and fire cracks. These are due to the intense heat concentrated against this particular piece. The lapping of the plates makes the distance from the inside of the boiler too great for the water to keep the outer lap sufficiently cool; therefore, the constant opening and shutting of the fire-doors allows the cold air to rush into the fire-box, causing violent expansion and contraction of the outer lap.

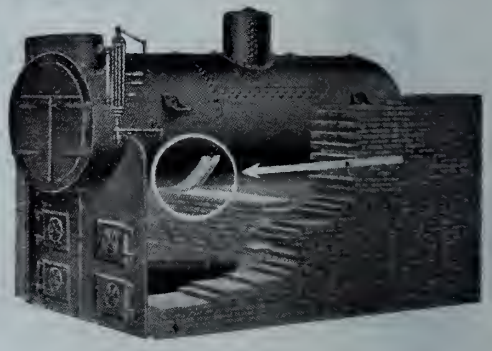
Our National Girth Seam Protector will overcome this difficulty, and will protect your seam from fire-cracking or leakage at this point.

If your girth seam is giving you trouble at the present time, have the seam caulked up, attach one of these Protectors and the seam will remain absolutely dry thereafter.

If your Boiler is not Fire-cracked it eventually will; prevent this by putting on a National Boiler Protector. You will save cost in repairs and prolong life of the boiler. All new boilers should be Protected.

Write to-day for our catalog giving names of many users of the National Boiler Girth Seam Protector and what they say about it.

Made in Canada.



The illustration above shows one complete set of this National Boiler Protector installed. Indorsed by Engineers and Boiler Inspectors and by Insurance Companies. So simply constructed is this National Protector that any fireman can attach it in 30 minutes.

National Boiler Protector Company of Canada

Warerooms and Factory: **322 Craig St. W.** ***Office:*** **910 New Birks Bldg., MONTREAL**

JOHNS-MANVILLE

Packings that pay dividends

A horsepower at the cross-head costs more than one at the coal pile. All your plant charges such as firing, oiling, superintending, overhead, all combine to increase it.

Heat unit for heat unit, power saved in steam is a bigger saving than power saved in coal. And the further you go into the plant the greater is this difference—the more this is true.

So that rod friction in a pump, an engine or compressor is a sizable item. Piston leaks and flange losses are not only nuisances but costly ones. Shut-downs are worse because production stops, but expense keeps going while economy takes a vacation.

All these things prove the importance of packing. All these things demand the use of good packings in materials and in design. Packings that "go dead" in the stuffing box are the finest rod brakes in the world. They ask you to slow up the engine to stop a leak.

Packings of shoddy materials wear out and establish the shutdown as a plant institution. Packings that give real service have been designed by stuffing box engineers. They have been built to minimize all common packing faults. You will recognize them by their first name, Johns-Manville. Their last name differs because of the variation in the work they are fitted for.

Here they are a standard line that covers every packing requirement:

Johns-Manville Sea Rings
Johns-Manville Service Sheet Packing
Johns-Manville Kearsarge Boiler, Man and Handhole Gaskets
Johns-Manville Universal Piston Packing
Johns-Manville Duplex and Hydraulic Packing
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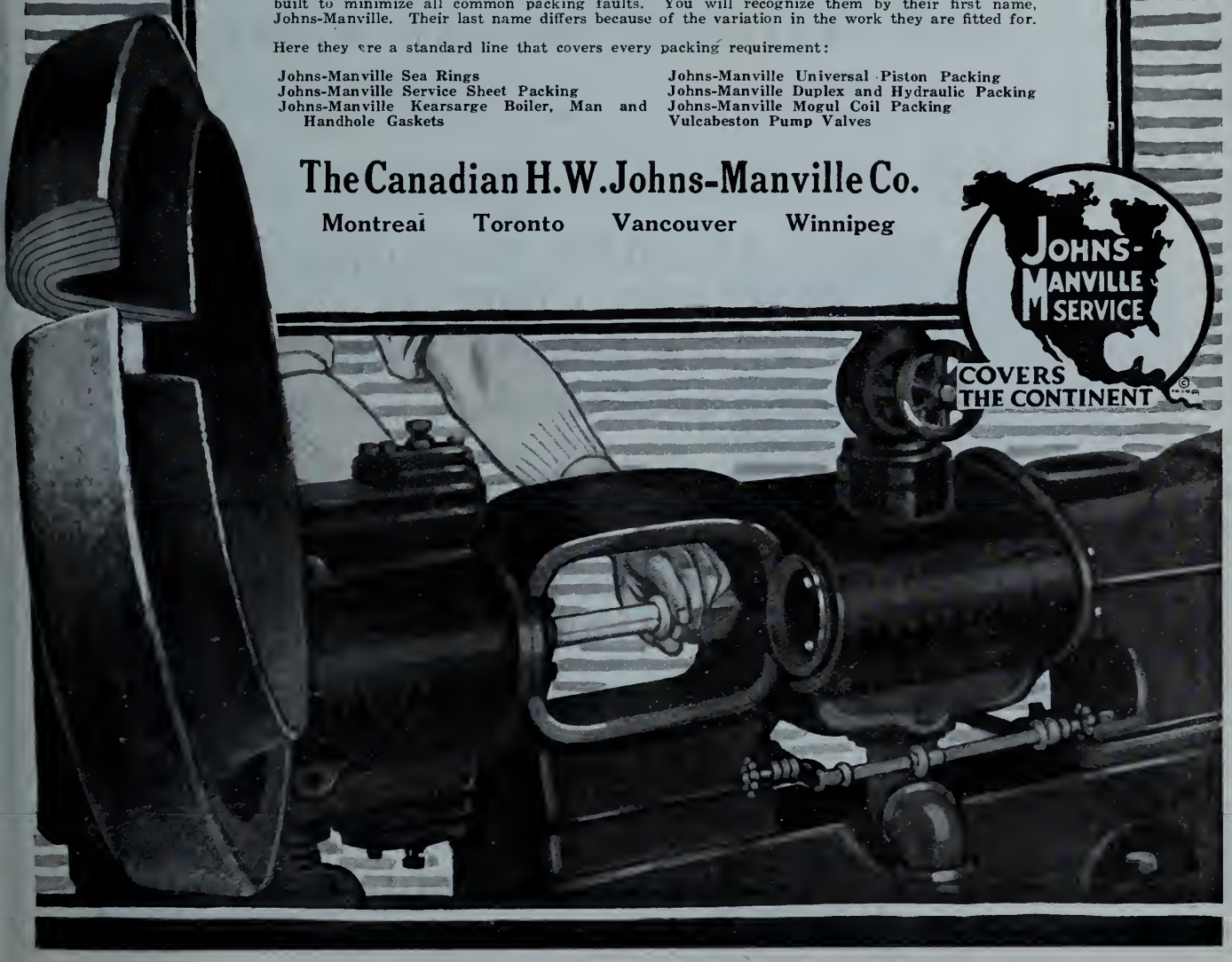
Vulcabeston Pump Valves

The Canadian H.W. Johns-Manville Co.

Montreal Toronto Vancouver Winnipeg



JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

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FOOD CONSERVATION

NATIONAL MOVEMENTS ARE BEING INAUGURATED
TO PREVENT ALL KINDS OF WASTE.
YOU CAN ASSIST

in these movements and Increase Your Profits by Installing a "LINDE" System in place of Unsanitary Methods.

LINDE SYSTEMS ELIMINATE WASTE

If the Linde Machine costs a little more to buy, it costs a good deal less to own; and that is true economy. It runs the longest and for the least money.

THE LINDE CANADIAN REFRIGERATION COMPANY, LIMITED

37 ST. PETER STREET, MONTREAL

Manufacturers of Quality Refrigerating Machinery

Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

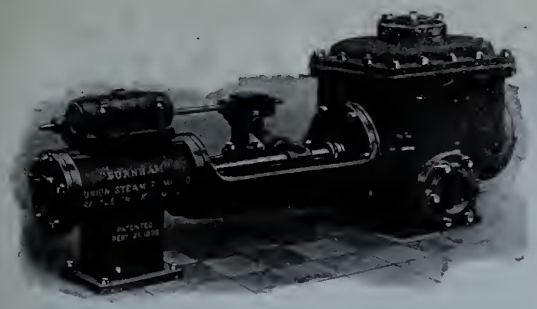
Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones. AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

Our Machines are in daily operation in Canada.

CORLISS and POPPET VALVE ENGINES.

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin



Burnham Vacuum Pump

A very large percentage of the Steam Pumps installed every year bear the name of

"BURNHAM"

Leading Architects, Consulting Engineers and Heating Contractors endorse "Burnham" Steam Pumps as the BEST, SIMPLEST AND MOST ECONOMICAL ON THE MARKET.

Thousands of Burnham pumps are in operation in connection with Vacuum Heating Systems; they are specially adapted for this service.

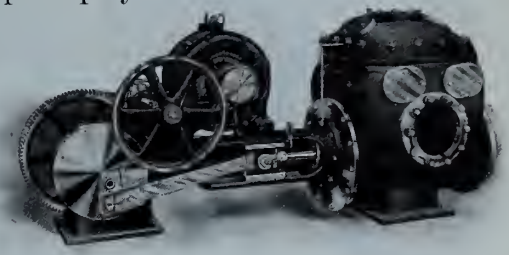
Standard Burnham Boiler Feed Pumps and Burnham Vacuum Pumps are kept in stock and can be shipped promptly.

If you want a pump for handling hot water, use the "Burnham."

Burnham Boiler Feed Pump

Ask for catalog

Darling Brothers
Limited
MONTREAL
Toronto Winnipeg



Union Electrically Driven Vacuum Pump

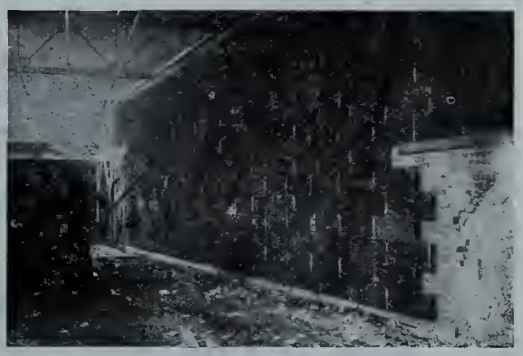
The Economy of an Ice Storage

Most ice plants (except in the far South) operate under heavy overload during the summer months, at reduced capacity in the spring and fall, and shut down entirely during the winter. Now, if these plants had suitable ice storages, insulated with

Nonpareil Corkboard Insulation

For All Cold Storage Rooms

their machines could be operated at nearly uniform capacity the year round, except when repairs were being made.



Insulating an ice storage room with Nonpareil Corkboard. Tropical Ice Company, New Orleans, La.

The slack season would be utilized for filling the storage. The expensive method of operating at less than capacity would be eliminated. The men would have steady employment; it would not be necessary to break in a new force in the spring. And then, when warm weather came, the reserve supply of ice would be used to take care of the large demand.

A properly designed ice storage, insulated with Nonpareil Corkboard, is a paying proposition.

Why not ask for information? It is free.

Armstrong Cork & Insulation Co., Ltd. 504 McGill Building Montreal, Que.

Also manufacturers of Nonpareil Cork Covering for cold pipes and tanks; Nonpareil Insulating Brick for boiler settings; Nonpareil High Pressure Covering for steam lines; Nonpareil Cork Machinery Isolation for deadening the noise of fans, motors and pumps; and Linotile for floors in offices and residences.

If any advertisement interests you, tear it out now and place with letters to be answered.

Something New

In the 4th Edition of our Fitting Catalog, recently issued, we illustrate a line of SCREW AND FLANGED AMMONIA FITTINGS, supplementing the large line of Standard YORK Valves and Fittings which are coming into more general use each year.

This is in line with our policy to design and place on the market Fittings and Apparatus that will make the application of MECHANICAL REFRIGERATION more convenient and economical.

From the number of orders received, it is quite evident that these SCREW AND FLANGED FITTINGS have met with the endorsement of the practical Engineer.

By their use YOU can—

SAVE WEIGHT WITHOUT LOSS OF STRENGTH OR CONVENIENCE.

ELIMINATE *ONE-HALF* THE *GASKET* JOINTS.

DO MORE RAPID PIPE FITTING, by ELIMINATING *ONE-FOURTH* OF *ALL JOINTS.*

as compared with full flanged fittings.

York Manufacturing Co.

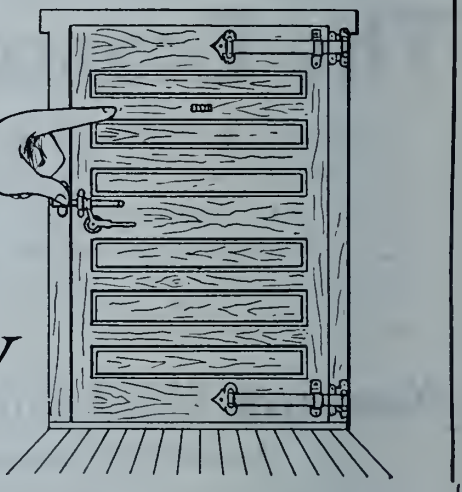
(Ice Making and Refrigerating Machinery Exc usively)

YORK, PA.

Represented in the Dominion by **CANADIAN ICE MACHINE COMPANY**

MONTREAL, 626 Coristine Bldg. TORONTO, 82 Chestnut St. WINNIPEG, 85 Lombard St

These Doors SERVE Because They SAVE



UNCLE SAM uses them. CANADA uses them. The biggest packers and storage houses use them. BECAUSE THEY SAVE DOLLARS "JONES" AND "NOEQUAL" Cold Storage and Freezer Doors (standard or fireproof) are rendering a National service because they shut out losses caused by poor, inefficient doors. May we have the pleasure of sending "The Economy of Patented Cold Storage Doors" which describes the SERVICE fully?

Jamison Cold Storage Door Co.

Formerly Jones Cold Storage Door Co. HAGERSTOWN, MD., U.S.A.

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

Where water analysis is made. General view of main labatoroty.

Science and Common Sense Combined

A Team Which is Curing Bad Feed Water Troubles For 30,000 Users of

DEARBORN TREATMENT

Is this not conclusive evidence that it is impossible to successfully treat all waters with the same preparation, and that it is absolutely essential that an analysis of the water under consideration be made in laboratories under the management of those who are thoroughly conversant with the subject of feed water treatment, in order that, when the analysis is once made, proper inferences and deductions can be obtained therefrom? We are absolutely sure that we are in the best position to intelligently handle your feed water troubles of anybody marketing so-called boiler compounds.

Send us a gallon jug of your feed water. We will analyze it free and let you know the approximate cost of keeping your boilers in good condition.

Dearborn Chemical Company of Canada, Limited

1220-30 Dundas Street, Toronto, Ontario, Canada

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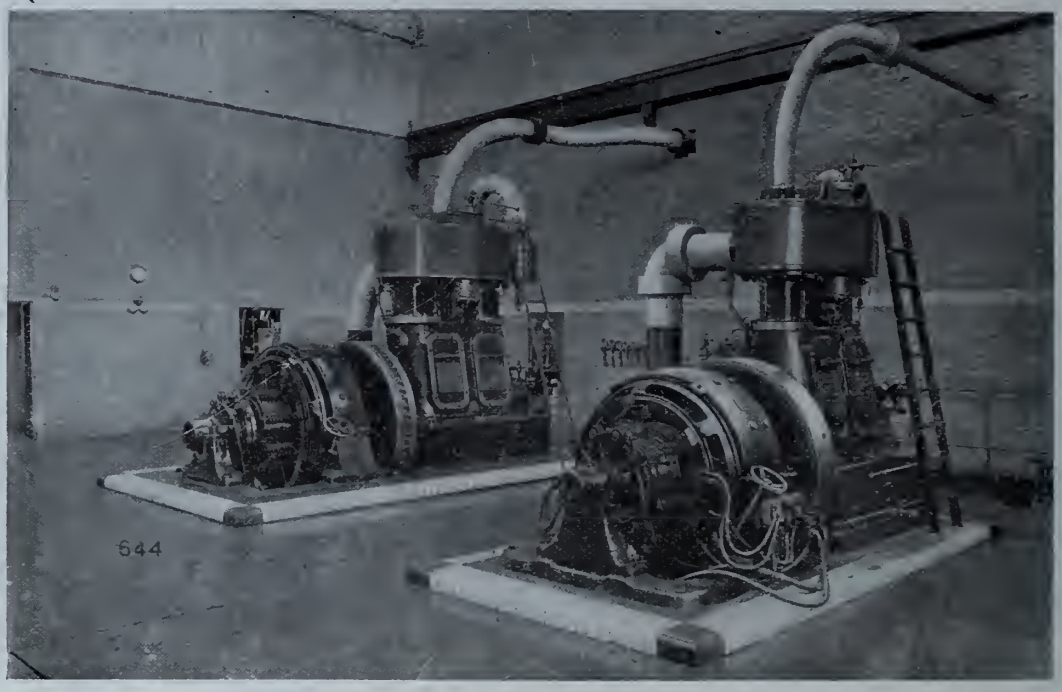
BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

Engineers

211 Board of Trade Bldg. :-: :-: MONTREAL

BEHIND this Diamond Trade-Mark on every Jenkins Bros.' Valve is the 53 years' reputation for Quality Products and trustworthy service.

Constant improvement to meet the varying conditions of valve practice and usage since 1864, has made possible the maintenance of the Jenkins Bros.' guarantee—

"If you will put a genuine JENKINS BROS.' VALVE on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight, or does not hold steam, oils, acids, water or other fluids longer than any other valve—**you may return it and your money will be refunded."**

Leading Engineers no longer buy valve service on manufacturers say-so. They insist on a definite record of accomplishments—facts. JENKINS BROS.' VALVES invite investigation on a fact basis.

AT ALL DEALERS

Catalogue No. 8 sent free on request.

103 St. Remi St. JENKINS BROS. Limited MONTREAL

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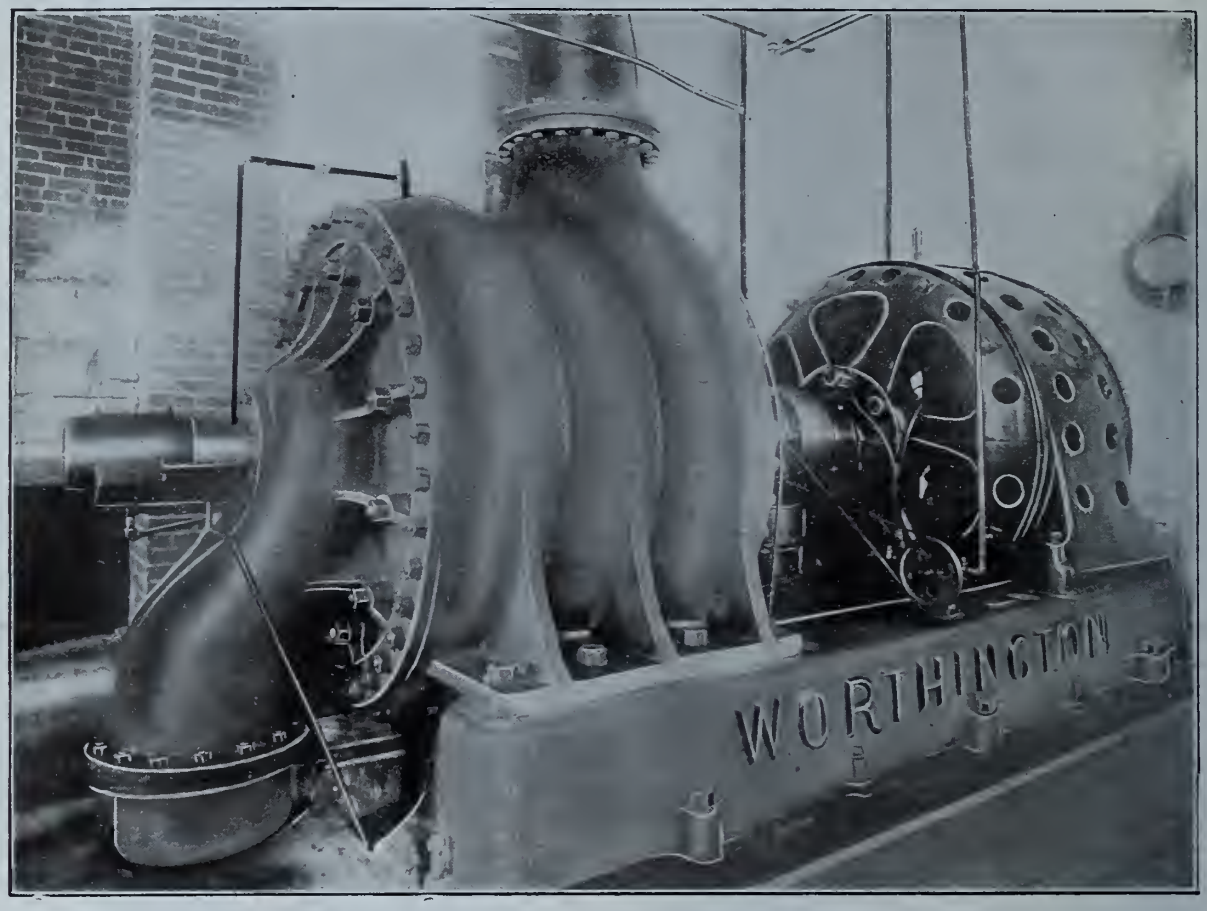
THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works : Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO October, 1917

Measuring Direct Returns

EVERY advertiser is entitled to know what he is getting for his money.

Every publisher is anxious that his paper shall be credited with the returns which it produces.

Yet the fact of the business is that it is next to impossible to trace all of the results of advertising. Direct returns as a measure of the value of space are therefore inadequate, and fail to indicate the accomplishments of the advertising.

This is indicated in a particularly convincing way by the experience of a well-known book publisher, whose business is handled entirely by mail, and is therefore altogether the product of advertising.

All ads published are keyed; direct advertising is likewise watched carefully, with special key numbers, so as to enable the publisher to note the percentage of returns from each piece of advertising sent out.

In spite of all this, however, the business which can be definitely attributed to specific forms of advertising is only about fifty per cent. of the total.

In other words, at least half of the business cannot be credited at all, and yet without any question it is the result of advertising, because all of the business of the house is secured in this way.

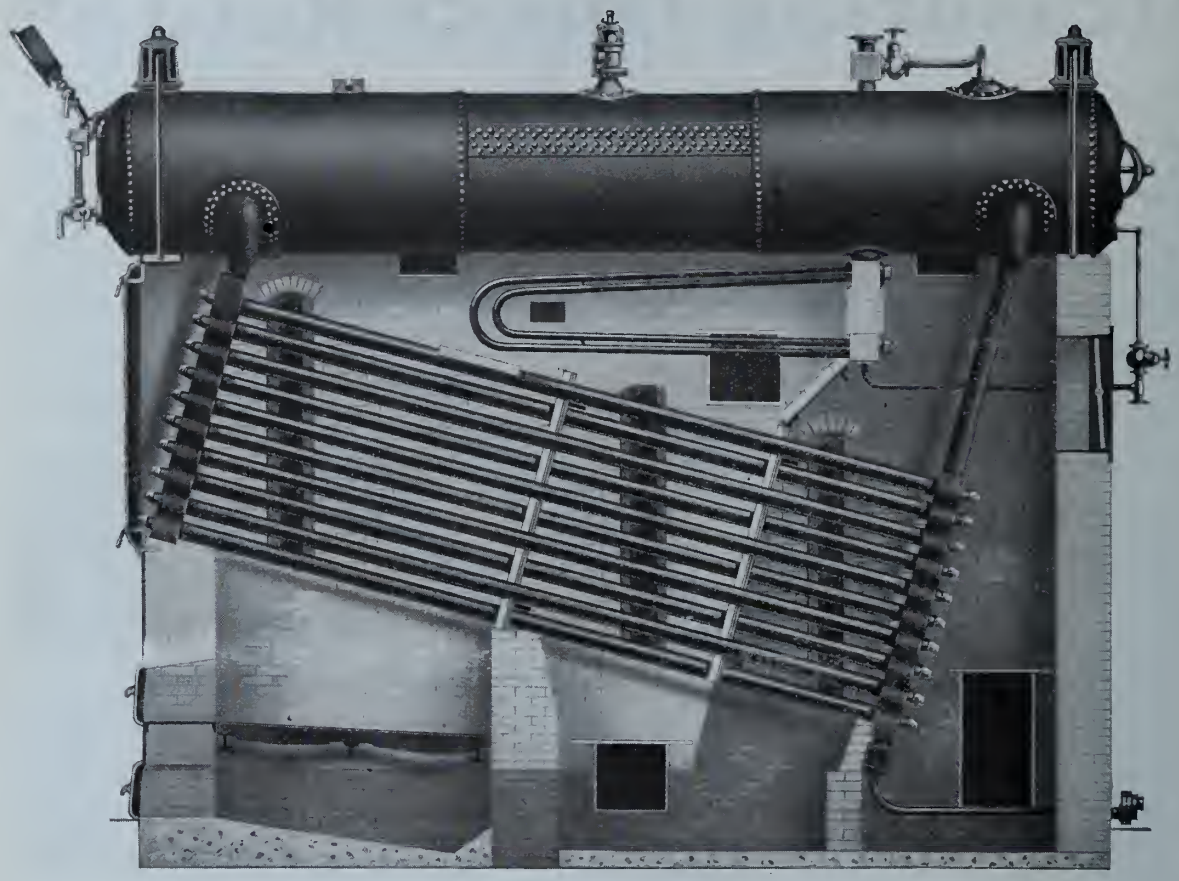
As a result of his experience, this book publisher now multiplies the direct results of advertising by two in order to get a line on the complete results.

Most advertisers in other fields would probably be able to use a larger multiple, especially if they have salesmen and are following up their advertising in other ways, because in that event the situation is complicated by the opportunity for personal solicitation to interpose and take up the work where it was left off by the printed advertisement.

Consequently, when an advertiser says he didn't get results, an analysis of his business would probably demonstrate that results were secured, but were not credited to specific media.—*Class.*

G. & McC. CO.

BOILERS



Sectional View, Standard Type "B," Sectional Water Tube Boiler, with Superheater.

G. & McC. Water Tube Boilers are fitted with large Steam and Water Drums, connecting nipples of increased size and straight 4" tubes, all of which insure

POSITIVE AND RAPID CIRCULATION, and INCREASED STEAMING CAPACITY

All parts subjected to steam pressure are made of FORGED STEEL

G. & McC. Engines and Boilers are giving satisfaction in thousands of Canada's leading industrial institutions. Write us for prices, plans, specifications, etc.

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

High Pressure Air Compressor Design and Application*

By Joseph M. Ford

Compressed air at high pressure is becoming an increasingly important medium in modern engineering practice and in naval warfare. The accompanying paper deals with the machines which produce high pressure air, leaving on one side the question of power transmission by compressed air. In passing, the principal advantages of this system are referred to, and will be seen to be of considerable value. They consist of the facility with which energy can be stored; the unlimited rate at which accumulated energy may be converted into useful work; and, apart from loss of efficiency, leakage cannot cause any awkward consequences.

TESTING MULTI-STAGE COMPRESSORS

ALTHOUGH extremely interesting results can be obtained from scientific tests of air-compressors, the manufacturer is usually content with tests for the efficiency of the machine. A purchaser requires to know the power required per cubic foot of air actually delivered, since this is the basis of comparison for compressors. The problem, then, is to determine exactly how much air is being delivered. The two methods usually adopted are: the "pumping-up" method and the orifice test. In the former the compressor is run at its full pressure, pumping into a reservoir, and from this latter the air is led to a receiver of known capacity. The details of the method are well known, being exactly the same in principle as used on tests of ordinary compressors for pneumatic tools. The orifice test is now being largely adopted, on account of the possibilities of error with the "pumping-up" method due to inaccurate temperature readings, oil and water in the bottles, etc. The orifice test method is also well known in connection with ordinary compressor work and need not be described.

Useful information as to the condition of piston rings and valves may be obtained from indicator cards, which also show to some extent the efficiency of the cooling. If, on applying Brauer's construction to the diagram, the compression line is found to be almost isothermal, it does not necessarily indicate that the cooling is almost perfect, as is sometimes stated. The line may indeed appear to be the isothermal, due almost certainly to leaky piston rings or suction valves. Lines giving an exponent value in PVn of less than 1.26 should be looked upon with suspicion.

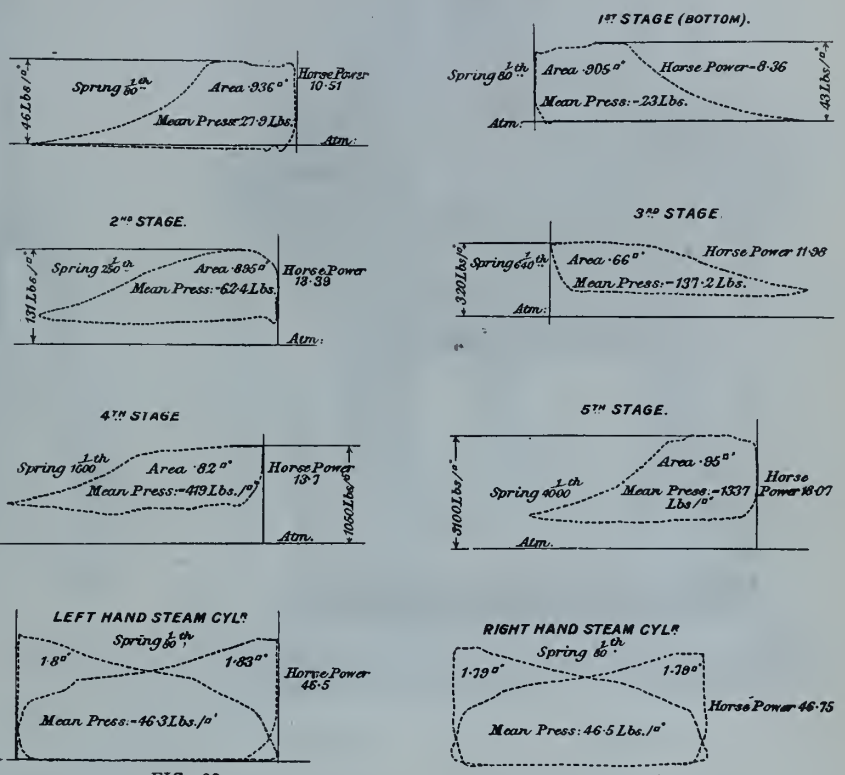


FIG. 32a. FIG. 32b.

If any stage pressure is very much above that estimated, the trouble will likely be due to the valves of the next higher stage leaking, or to its own delivery valve not being tight. Judicious use of the cylinder drain cocks, and the behavior of the stage pressure gauges immediately on shutting down, enables conclusions to be drawn as to the source of trouble without the necessity of taking indicator cards.

Maintenance of Compressors

The usual practices of engine maintenance apply to compressors, but unfortunately the care and attention given to these machines is frequently less than that necessary. Particularly is this the case in some Diesel engine plants, where the compressor, until it gives trouble, is looked upon as an engine detail. The lubricating system, above all, must be kept in the highest state of efficiency, as failure in, say, the high-pressure stage, where these is usually considerable ring friction, generally leads to a cracked

*Conclusion of paper read before the Greenock (Scotland) Association of Shipbuilders and Engineers. See issues of May 31 and 28 for previous instalments.

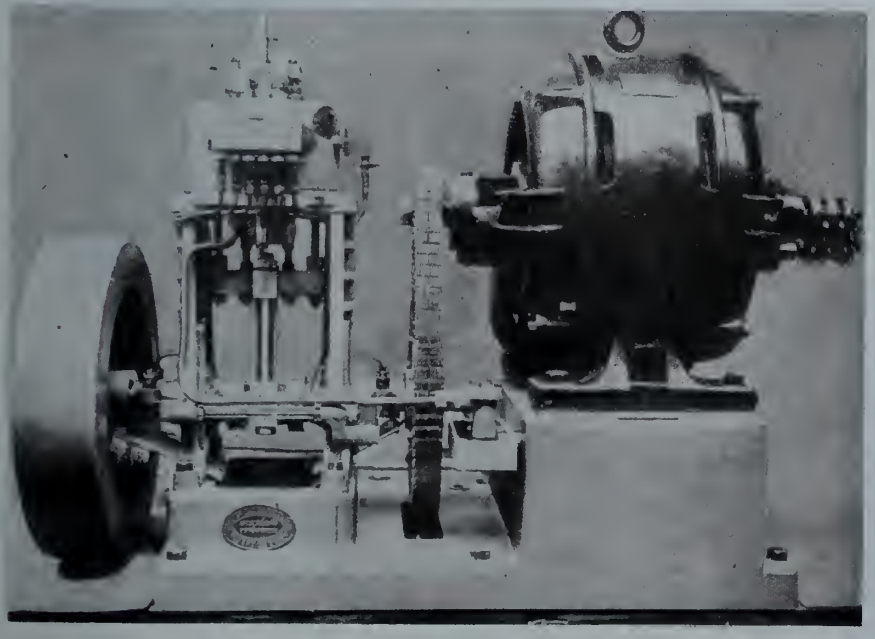


FIG. 30. "BROTHERHOOD" THREE-STAGE COMPRESSOR, 600 CU. FT. CAPACITY.

cylinder, which may not be the limit of the damage.

When the circulating water is chalky or muddy, the cooling system must be periodically cleaned if the highest efficiency is to be maintained. Valves should be examined from time to time for cracks. It is of the utmost importance that relief valves should be in perfect order, for these are in every way as important as a boiler safety valve, and under no conditions whatever should the valves be wedged or otherwise put out of operation to stop a leak. They should be tested for blowing off at frequent intervals. If stage pressures are rather higher than normal, it means probably, as previously explained, that valves are leaking.

Provided the pressures are not excessive, no trouble will result from running in this condition, but matters should be put right at the first opportunity. In justice to Diesel engine air-compressors, it must be stated that the frequency with which the engine log book records "compressor trouble" is due in many cases to negligence. There is still a big scope for improvement in the design of multi-stage compressors.

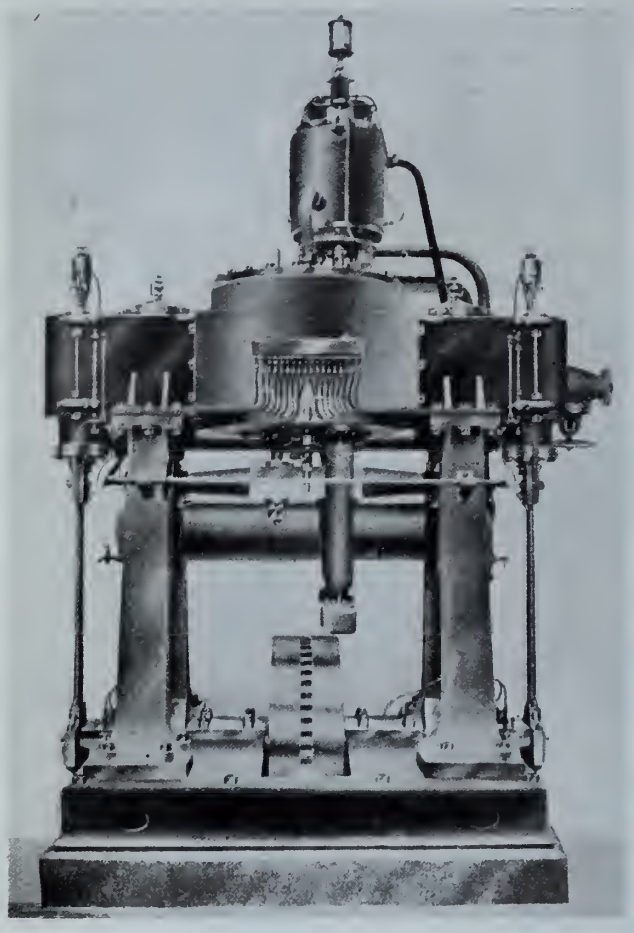


FIG. 31. "BROTHERHOOD" FIVE-STAGE COMPRESSOR, 10,000 CU. FT. CAPACITY.

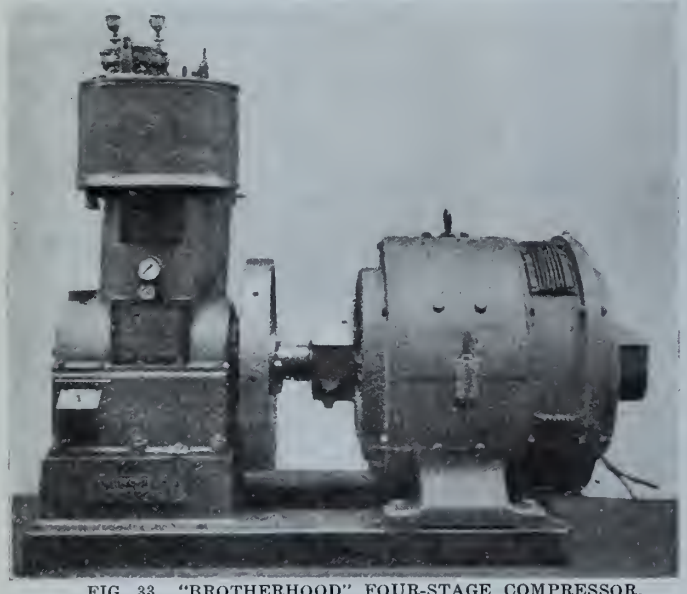


FIG. 33. "BROTHERHOOD" FOUR-STAGE COMPRESSOR.

Modern Machines

Through the courtesy of various makers it has been possible to reproduce several photographs and drawings of some of the latest high-pressure air-compressors, and a glance at these will show at once the divergence which exists in design.

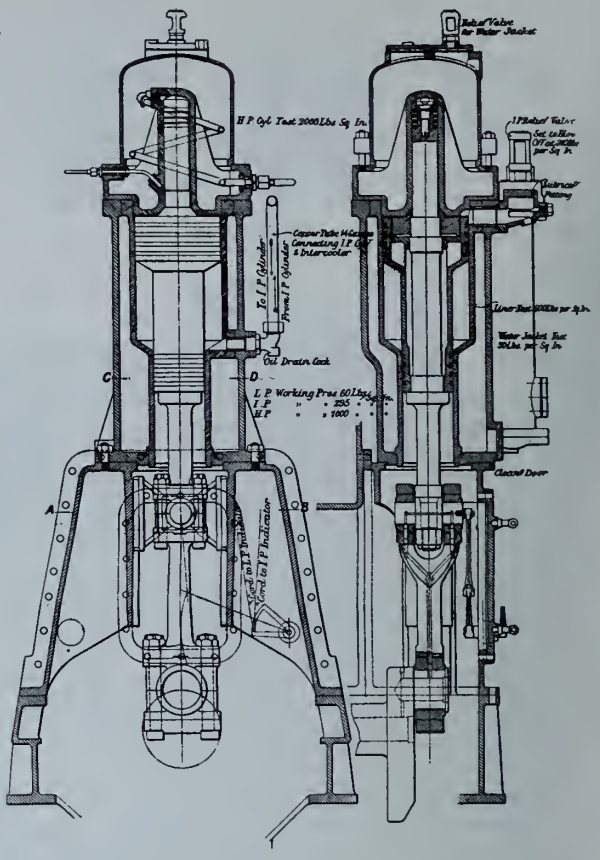


FIG. 35.

FIG. 36.

Fig. 30 shows a small three-stage compressor, chain-driven, and having a capacity of 600 cubic feet of free air per hour, compressed to 3,000 lb. per square inch. As has been already explained, in small machines the tendency is to reduce the number of stages of compression for a given final pressure, and this statement is borne out by a comparison between this machine and that shown in Fig. 31.

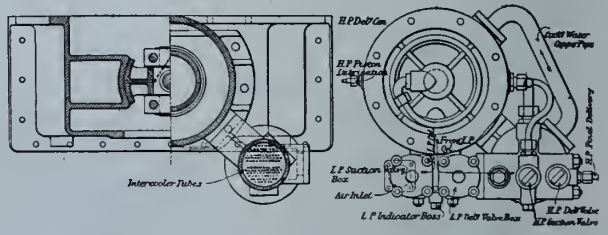


FIG. 37.

FIG. 38.

Although the working pressure of this latter is the same, viz., 3,000 lb. per sq. inch, the capacity is 10,000 cub. ft. free air per hour, or more than 16 times as great as that of the small machine, and in this case the compression is divided into five stages. The machine is steam-driven, two double-acting steam cylinders being at the ends and the air cylinders in the centre, while the air piston rods are coupled side by side to the horizontal bridle which is attached at its extremities to the steam line crossheads.

A complete set of indicator diagrams from this machine is given in Figs. 32 A and B. It may be mentioned that the shape of the suction lines in the cards from the fourth and fifth stages results from the fact that the cylinder volumes are fairly large compared with the cubical contents of the intercoolers, the lowest point on the line indicating the commencement of transfer. The comparatively small clearance volume in the first stage cylinders, shown by the rapid drop in pressure on the back stroke, is also worthy of note, the reasons for the small volume having previously been discussed.

Fig. 33 shows a four-stage direct-coupled machine by the same builders, capable of charging a 45 cub. ft. reservoir to 2,000 lb. per sq. inch in 80 minutes when running at 250 r.p.m., whilst the five-stage direct-coupled machine shown in Fig. 34, charges a 40 cub. ft. receiver to 3,000 lb. per sq. inch in one hour at 350 r.p.m.

A point to which attention may be directed is that the intercoolers on these machines are generally of the submerged type, that is, the cooler consists of a copper or steel pipe coiled round the cylinders in the tank. This tank construction simplifies very considerably the cylinder castings, and the cooling effect is probably enhanced due to the whole of the connections being submerged, but of course this method is not always admissible. The cooling is still further improved by water injection, the water in the case of a steam-driven machine being obtained by condensation, and therefore quite free from foreign matter.

The piston packing in these compressors is of the fibre-ring type, the high-pressure gland fibres being fitted in removable boxes, which can be repacked at the bench—an obvious advantage. All valves, which are mainly of the thimble type, have removable seatings, so that a replacement is readily effected.

An unusual feature is the provision of an indicator to show that the circulating water is flowing through the casing, which in many cases is very convenient, as it is not always easy to arrange for the water to be discharged into a funnel. The importance of maintaining the circulation will be readily understood from a study of the temperature charts previously given.

Diesel Engine Compressors

Special attention has been devoted to the design of air-compressors for Diesel engines; product of one firm ranging from small hand-driven machines for charging starting bottles in case of emergency, to those used on some of the largest machines yet constructed. A patented design of three-stage compressor for 1,000 lb. per sq. in. working pressure, which has given very satisfactory results from marine work, is shown in Figs. 35 to 38, a special feature of this machine being the arrangement of the second or intermediate stage. By suitably proportioning the cylinder and intercooler dimensions it is possible to dispense entirely with valves in this stage, which means that the intercooler volume is part of the intermediate pressure cylinder clearance.

The principle will perhaps be better understood by reference to Figs. 39 and 40, which shows the "Reavell" patent V class duplex compressor. The air is delivered from the low-pressure stage down through the intercooler to the second stage cylinder, and on the down stroke it is compressed, and again passes up through the same intercooler on its way to the high-pressure cylinder—the high-pressure suction pipe being in direct connection with the low-pressure delivery passage. The only modification to the low-pressure valves which this entails is that the valve cover must be arranged to withstand the intermediate pressure delivery pressure instead of the low-pressure as is usual.

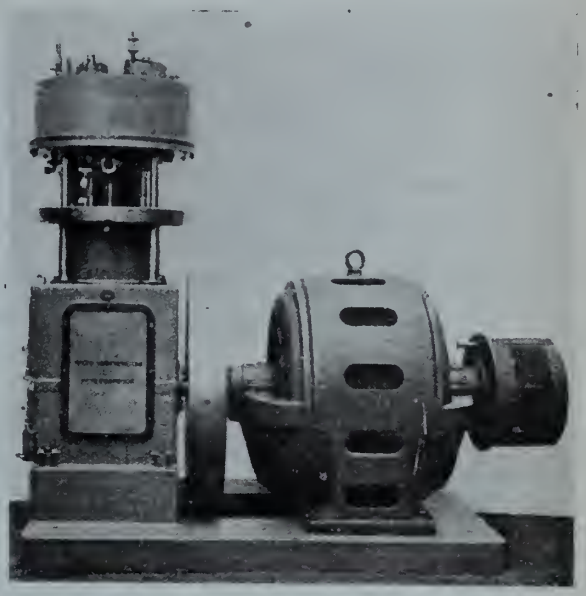


FIG. 34. "BROTHERHOOD" FIVE-STAGE COMPRESSOR.

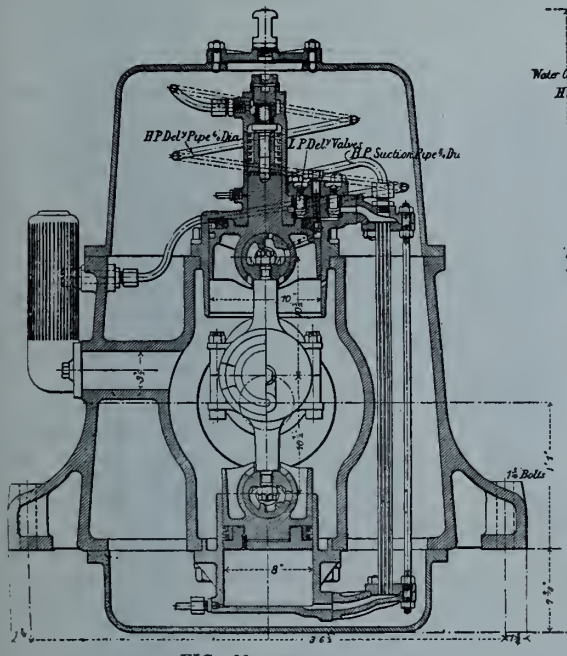


FIG. 39.

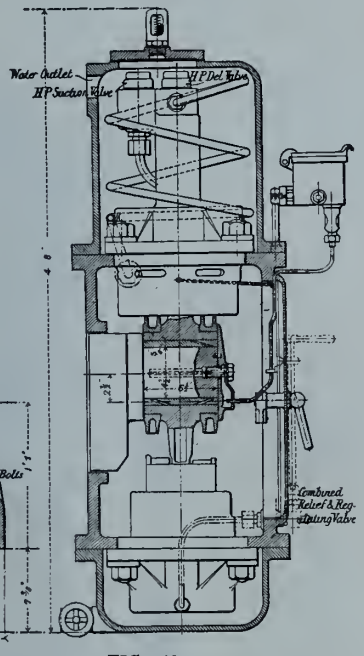


FIG. 40.

Since the air passes through the same intercooler twice, only one of these is required, instead of two as with other designs, and apart from the simplicity of construction resulting therefrom, the efficiency is considerably increased owing to the fact that the second stage of compression is effected in the cylinder and cooler itself—the reasons for improved efficiency having already been dealt with. The marine compressor under consideration is exactly the same in principle, only a single intercooler being provided.

In the remarks on cylinder clearance volume, it was pointed out that in a Diesel engine compressor it is sometimes advantageous to have considerable cylinder clearances, and this is borne out by a study of this machine. The clearance volume in the low-pressure stage is, of course, reduced as far as possible, the method of securing the piston to the rod being such that the clearance space is the minimum. The intermediate-pressure clearance, however, is very large, being, in fact, the whole volume of the intercooler tubes and connecting pipe; whilst the high-pressure clearance is also very large, being the volume of the coiled aftercooler in the jacket. Apart from the features which have already been dealt with in the notes on clearance, this arrangement allows the high-pressure valves to be located outside the water jacket—a distinct advantage—but, further, the air is cooled to a large extent after compression before it cooled to a large extent after compression before it reaches the delivery valve, which cooling undoubtedly lengthens the life of the

latter and reduces carbonization troubles. The theoretical indicator diagram which results from these large clearances and "valveless intermediate" construction is

FIG. 42.

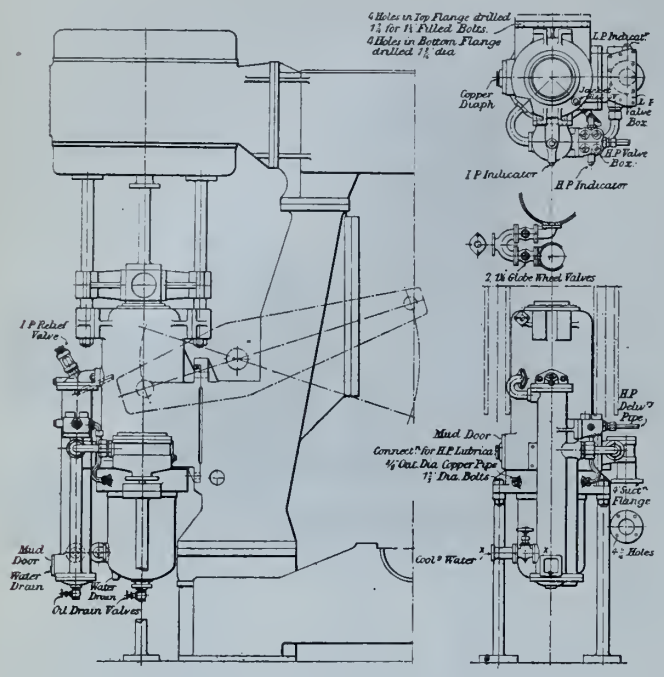


FIG. 41. FIG. 43.

cracked, it might prove a little difficult to remove the sleeves so as to permit the withdrawal of the liner. This compressor is driven from the forward end of the engine crank shaft, and the stage pressures adopted in this case are: low pressure 60 lb. per sq. inch, and intermediate pressure 295 lb. per sq. inch, when working at its full capacity against a final delivery pressure of 1,000 lb. per sq. inch.

In modern high-power marine Diesel engines of the two-cycle slow-running type, it has become usual, for various reasons, to drive the scavenging pumps by means of levers, in accordance with

Figs. 41 to 44 show the compressor arrangement which has been successfully adopted on a large British marine engine, whilst sections of the machine itself are given in Figs. 45 to 47. This compressor also embodies the Reavell "Valveless intermediate" patents, the direct passage between the intermediate-pressure cylinder and the intercooler being clearly shown in Fig. 46. The simple construction of the intercooler is worth noticing, the tubes, which are usually of copper, being expanded into the steel tube plates. When the thickness of the latter, gauge of the tubes, and method of expanding are carefully chosen, this system leaves little to be desired, and, further, it permits of a greater cooling surface being obtained, for the same overall dimensions, than would be the case were the usual ferrule system adopted. However, the tubes must be of the highest quality material and must be thoroughly tested before use, for should a tube failure occur, it would be more difficult to repair than in the case of a cooler with ferrules.

FIG. 46.

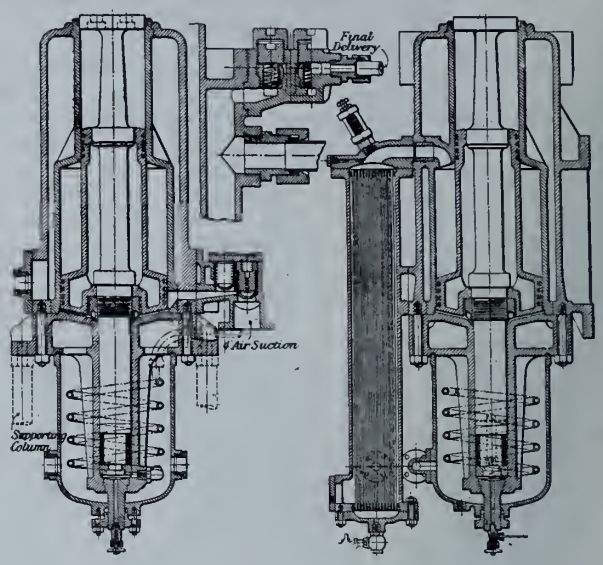


FIG. 45. FIG. 47.

The valve arrangements are seen in Figs. 45 and 47, the low-pressure suction and delivery valves being interchangeable, whilst the high-pressure valves, which have removable seats, are also interchangeable. This, of course, reduces the number of spares which have to be carried, in addition to obviating the possibility of mistakes when reassembling after an overhaul.

To minimize the danger, should the high-pressure cooling pipe or any other part under pressure give out, three large bursting diaphragms are provided on the water jacket (two being on the high-pressure bonnet, and one on the opposite side of the low-pressure valve box); these are ruptured, thus giving free egress to the water and air, when the pressure in the jacket exceeds a pre-determined figure. It may be remarked that the arrangement of this compressor, with the high-pressure cylinder at the bottom, is unusual, and to avoid difficulties which might otherwise result from accumu-

given in Fig. 54, annexed, and applies to all machines of this type.

As far as the actual construction of the machine is concerned, attention may be called to the very effective cylinder jacketing, especially at the breech end of the low-pressure cylinder; also the simplicity of the high-pressure cylinder casting, with its absence of valve pockets, should be noted. It might be noted that one small point which is open to criti-

FIG. 48. FIG. 49. FIG. 52. FIG. 53.

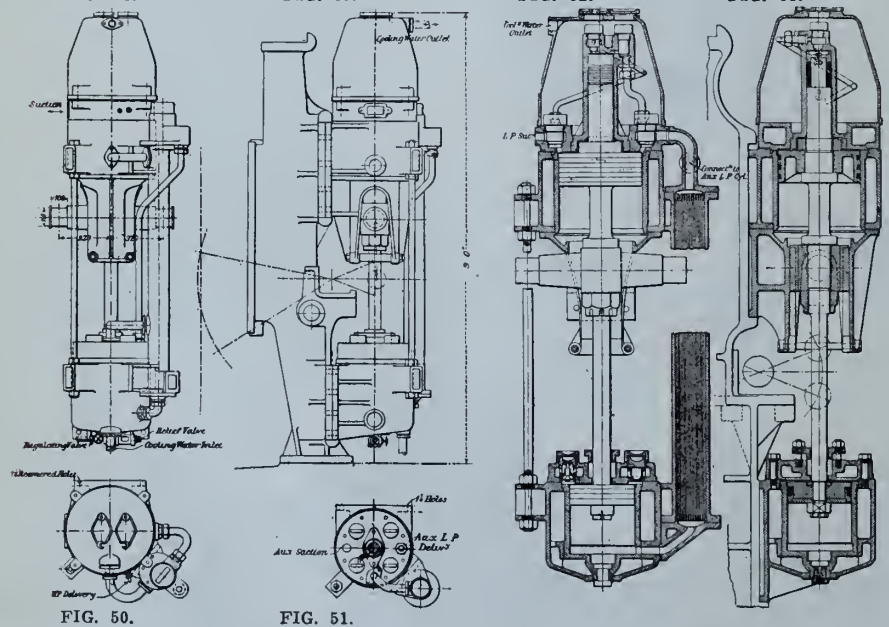


FIG. 50. FIG. 51.

cism is the method of making the air connection between the jacket and the liner —viz., by the forced-in sleeves, for should a liner by any chance become scored or the well-known marine practice, and in many cases the compressor drive can conveniently be arranged in conjunction therewith.

lated oil in the latter, special provision is made for draining.

Another lever-driven compressor as used on engines of continental design, is shown in Figs. 48 to 53, and, as in the previous machines, there are no valves in the second stage. In this case the intermediate-pressure cylinder is located below the crosshead, and a patented

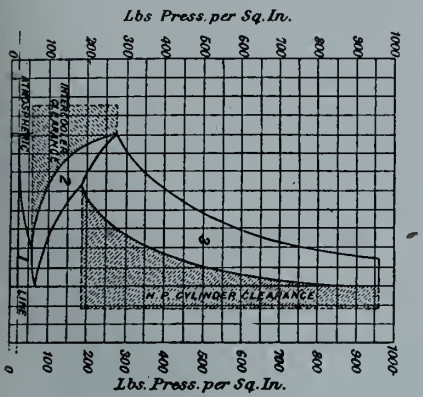


FIG. 54.

pressure cylinder, the whole then passing to the intermediate cylinder in the usual way. By this simple means, the capacity of the compressor can temporarily be increased by about 30 per cent., which means that it will not be necessary to keep such a large auxiliary machine running as would otherwise be the case. As

pedo work, for a delivery pressure of 3,500 lb. per sq. inch. The capacity at this pressure and 340 r.p.m. is 30 cub. ft. of free air per hour. The machine is a four-stage steam-driven type and is a self-contained unit, the inverted steam cylinder, as will be seen, being placed beneath the air cylinders. Apart from

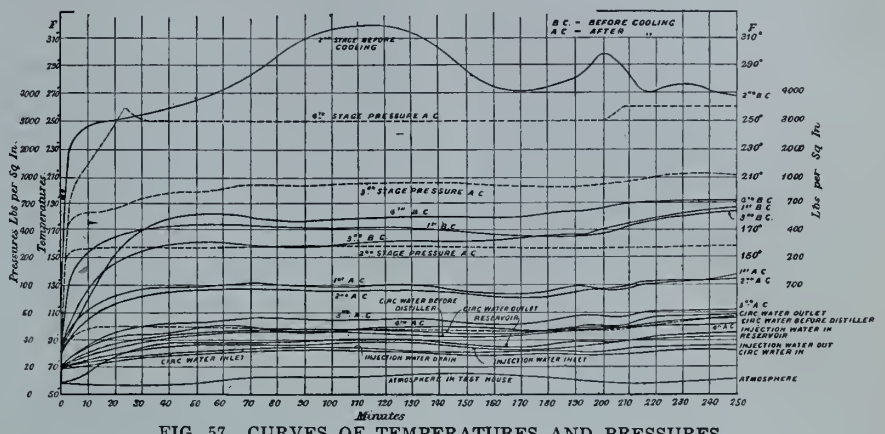


FIG. 57. CURVES OF TEMPERATURES AND PRESSURES.

feature is the utilization of the end of this cylinder as an auxiliary low-pressure cylinder. Normally the valves in the cover of this cylinder are inoperative, but when there is considerable manoeuvring, and in consequence a big demand for air, such as obtains on entering port, they can be brought into action, either automatically or by hand, when, as will be seen from the sections, this cylinder delivers air into the top of the intercooler at the same time as the main low-

would be expected, very special attention has to be paid to the proportioning of such a machine, on account of the alteration to the distribution of the total work which results from such a device. In this particular machine the high-pressure valves are arranged directly in the cylinder head, access to them being obtained from the engine upper platform through the small covers on the bonnet.

Fig. 55 shows a well-designed machine of a type similar to those used for tor-

the very compact arrangement which is thus obtained, the drive is direct, so that the stresses in the connecting rods, for example, are much less than they would be with the "side-by-side" arrangement. Another noteworthy feature in the design is the provision of a separate cylinder for each stage of compression, instead of having recourse to differential pistons, which latter arrangement, although possessing many advantages, is decidedly inferior from a thermal point

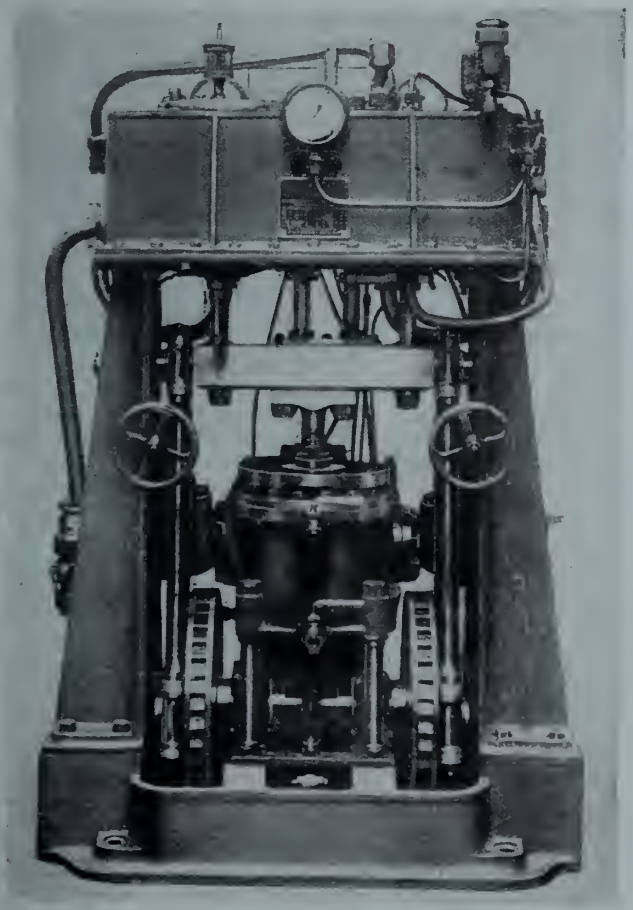


FIG. 55. "GENERAL" FOUR-STAGE COMPRESSOR.

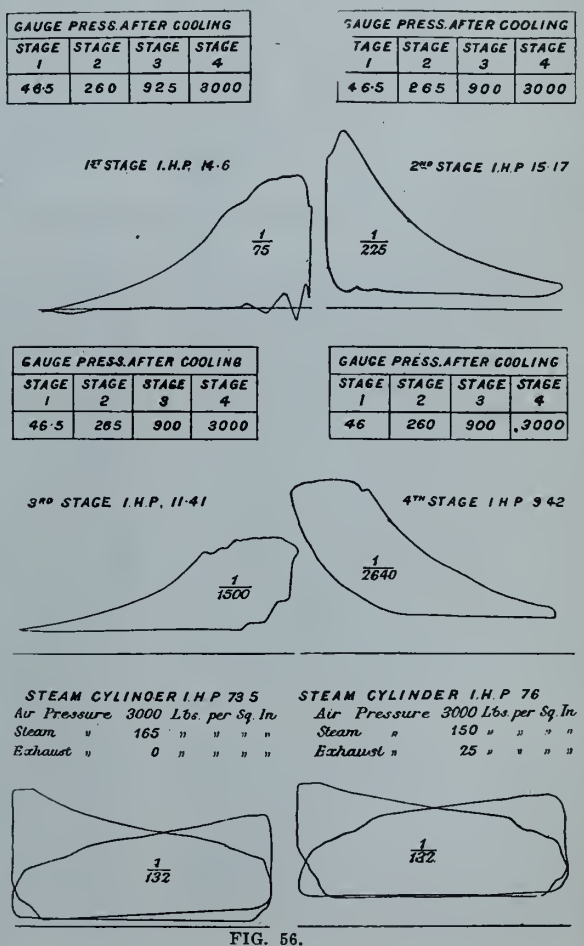

GAUGE PRESS. AFTER COOLING
STAGE 1 | STAGE 2 | STAGE 3 | STAGE 4
46·5 | 260 | 925 | 3000
GAUGE PRESS. AFTER COOLING
TAGE 1 | STAGE 2 | STAGE 3 | STAGE 4
46·5 | 265 | 900 | 3000
1st STAGE I.H.P. 14·6
1/75
2nd STAGE I.H.P 15·17
1/225
GAUGE PRESS. AFTER COOLING
STAGE 1 | STAGE 2 | STAGE 3 | STAGE 4
46·5 | 265 | 900 | 3000
GAUGE PRESS. AFTER COOLING
STAGE 1 | STAGE 2 | STAGE 3 | STAGE 4
46 | 260 | 900 | 3000
3rd STAGE I.H.P. 11·41
1/1500
4TH STAGE I H P 9 42
1/2640
STEAM CYLINDER I.H.P 73 5
Air Pressure 3000 Lbs. per Sq. In
Steam " 165 " " " "
Exhaust " 0 " " " "
STEAM CYLINDER I.H.P 76
Air Pressure 3000 Lbs. per Sq. In
Steam " 150 " " " "
Exhaust " 25 " " " "
1/132
1/132

FIG. 56.

of view, on account of the reduced cooling surface per unit of heat generated. In addition to the effective cooling resulting from the arrangement adopted, intercoolers are provided, and, further, a distiller is fitted which provides pure water for injection into the air cylinderss.

Figs. 56 and 57 and the table show the results of an exhaustive trial carried out by the builders on one of these machines. The curves reveal many points of interest, whilst an idea of the distribution of work through the machine can be obtained from the cards, which show a mechanical efficiency of about 68 per cent.—a very satisfactory result considering the large amount of piston friction and the two connecting rods, etc. The card from the fourth stage would seem to indicate a large cylinder clearance, but it may be pointed out that sometimes the indicator itself adds quite a large percentage clearance to a small high-pressure cylinder—especially when connections are long, due to the necessity of passing through a water jacket. Regarding the intercooling effect as shown by the curves, it might be thought that improvement could be effected. In practice, however, a long continuous run at full pressure is very seldom required of compressors of the charging type—therefore the intercoolers need not be of such dimensions as those required for a continuous duty machine. Again, the question of economy is of less importance.

With the increasing number of applications of high-pressure air, and especially with the growth of the Diesel engine industry, more attention is being paid to the design of high-pressure machines, and in view of the scarcity of trustworthy literature on the subject, the foregoing brief outline of some of the points which arise may serve a useful purpose.

AIR-COMPRESSOR TRIAL, JANUARY 11, 1915; ENGINE No. 539. BY THE GENERAL ENGINE AND BOILER CO. NEW CROSS, LONDON

Gauge Pressures after Cooling. Stage 1	Stage 2	Stage 3	Stage 4	Boiler Pressure.	Back Pressure.	Counter. Revs.	Time, Mins.	Air Inlet Atmosphere.	First Stage before Cooling.	First Stage After	Second Stage Before.	Second Stage After.	Third Stage Before.	Third Stage After	Fourth Stage Before.	Fourth Stage After.	Circulating Water Inlet	Circulating water before Distiller.	Circulating Water Outlet.	Injection Water Inlet.	Injection Water Drain	Pressure,
												Pump Up.										
								deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.	deg. F.
42	248	500	500	155	6	1,020	3-0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
46	252	580	1,000	150	7.5	2,380	7-0	57	156	109	250	101	122	83	95	78	68	81	82	78	78	60
46	260	580	1,500	150	8	3,680	11-0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
46	262	581	2,000	150	8	4,850	14-25	56	162	116	250	104	135	88	130	81	74	82	86	78	78	73
48	270	600	2,500	150	9	5,980	17-45	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
49	280	640	3,000	155	10	7,040	20-45	56	165	124	150	116	150	91	152	82	76	86	93	78	78	79
												Three Hours' Run.										
49	280	700	3,500	127	10	8,030	23-40	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
49	270	800	3,000	140	9.5	14,050	40-0	58	172	128	260	127	157	101	178	92	75	92	94	87	78	87
48	280	826	3,000	140	9.5	18,080	53-0	58	172	128	260	125	157	101	178	92	80	96	99	88	80	85
48	280	910	3,000	135	9	23,600	70-0	61	173	131	310	129	160	106	180	97	81	97	99	87	81	88
48	280	902	3,000	135	9	27,900	83-0	62	172	127	300	125	152	101	175	93	78	93	95	88	84	87
48	285	910	3,000	135	9	33,050	98-0	62	172	128	320	127	162	104	177	97	80	96	96	90	82	88
48	285	925	3,000	137	9	38,170	113-0	63	171	128	320	128	163	104	178	96	81	96	98	90	84	88
48	285	925	3,000	137	9	42,800	128-0	64	171	128	320	129	163	105	180	95	81	97	99	90	81	85
46	285	925	3,000	150	9	53,781	161-0	62	167	120	270	122	163	101	179	92	81	93	99	84	79	87
47	285	920	3,000	125	9	58,664	176-0	62	166	124	270	123	161	101	180	94	82	95	95	85	81	88
47	280	910	3,000	140	9	63,701	191-0	60	168	129	280	130	170	109	185	100	80	99	100	90	83	89
47	275	900	3,000	135	9	67,360	202-0	60	168	127	300	128	163	104	180	98	78	97	98	88	81	89
50	285	920	3,500	150	10	72,306	217-0	62	175	131	270	134	173	110	189	101	79	102	105	95	85	92
55	320	1,050	3,500	155	10	77,276	232-0	64	182	135	275	136	178	112	192	101	81	105	108	97	86	94
58	330	1,040	3,500	195	10	82,256	247-0	66	183	138	265	135	177	113	191	102	82	106	109	98	87	95

Capacity of Machine—30 Cub. Ft. of Air per Hour at 3,000 lb. per Sq. In.

	Average Revolutions per Minute	Circulating Water lb. per Min.	Injection Water. lb. per Min.	Average Steam Pressure lb. per sq. in.	Average Exhaust Pressure lb. per sq. in.
Pump up	338	244	0.6	151	8
Three hours' run	331	248	0.56	146	9

WOOD FUEL VS. COAL

THE fuel value of two pounds of wood is roughly equivalent to that of 1 pound of coal. This is given as the result of certain calculations made in a Government forest service laboratory, which show also about how many cords of certain kinds of wood are required to obtain an amount of heat equal to that in a ton of coal.

Certain kinds of wood, such as hickory, oak, beech, birch, hard maple, ash, elm, locust, longleaf pine, and cherry, have fairly high heat values and only one cord of seasoned wood of these species is required to equal one ton of good coal. It takes a cord and a half of shortleaf pine, hemlock, red gum, Douglas fir, sycamore, and soft maple to equal a ton of coal, and two cords of cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce and white pine.

Equal weights of dry, non-resinous woods, however, are said to have practically the same heat value, regardless of species, and as a consequence it can be stated as a general proposition that the heavier the wood the more heat to the cord. Weight for weight, however, there is very little difference between various species; the average heat for all that have been calculated is 4,600 calories, or heat units, per kilogram. A kilogram of resin will develop 9,400 heat units, or about twice the average for wood. As a consequence, resinous woods have a greater heat value per pound than non-resinous woods, and this increased value varies, of courdse, with the resin content.

The available heat value of a cord of wood depends on many different factors. It has a relation not only to the amount of resin it contains, but to the amount of moisture present. Furthermore, cords vary as to the amount of solid wood they contain, even when they are of the standard dimension and occupy 128 cubic feet of space. A certain proportion of this space is made up of air spaces between the sticks, and this air space may be considerable in a cord made of twisted, crooked and knotty sticks. Out of the 128 cubic feet, a fair average of solid wood is about 80 cubic feet.—"Canada Lumberman."

COAL PRODUCTION IN CANADA

REPORTS from the principal coal mine operators in the Dominion for the six months ending June 30, last shows a total coal production of 6,154,420 short tons. Nova Scotia led all other provinces with a total of 3,058,216 tons. Alberta was second with 1,763,506 tons and British Columbia third with 1,100,100 tons. Exports averaged around 130,000 tons per month, and were considerably lower than for the same period a year ago. Total production for 1916 was 14,483,395 tons. Bituminous imports for the first six months of the year were 6,392,378, compared with 5,848,289 for the same period a year ago. Anthracite imports up to June 30, 2,231,857, and for the corresponding period last year 2,097,151.

Total coke production in Canada for six months was 580,997. Imports were 490,830, and exports 8,905. Production of coke includes only the coke made in bee-hive or by-product ovens and does not include coke made by gas companies in retorts.

RECENT activities of the Society for the Promotion of Engineering Education included the publication of an article on "Technical Book Writing," by J. A. L. Waddell, consulting engineer, Kansas City.

ENGINE-HOUSE EFFICIENCY

By L. E.

AN important difference is to be observed between the boiler house and the engine house as regards the securing of maximum efficiency. In the boiler house, once the design of the plant is satisfactorily settled, everything depends upon the operator. In the hands of a skilful fireman an ill-designed plant may be made to give quite passable results; in the hands of an unskilful fireman the best plants may show a deplorably poor efficiency. Even with mechanical stokers the personal factor is important; with hand firing it is also important. But when one passes from the boiler-house to the engine-house the order is reversed; the determining factor is here the machine rather than the man. If the engine is well designed for the load, and conditions which it has to meet, if the loads on the cylinder are well proportioned, and the valves correctly set, then the engine when set to work will give of its best without any large amount of supervision or alteration by the engineer. Care must, of course, be exercised in seeing that lubrication is perfect, the cylinder must be indicated regularly, to see that the valves are in correct adjustment, and slight alterations made accordingly; the valves and piston must also be tested regularly for steam tightness.

Generally speaking, however, the operations going on in the engine are entirely automatic, and do not require the constant control of the engineer. The normal operation of the engine on which the steam consumption depends is out of the control of the engineer after he has correctly adjusted the parts. For these reasons, power plant owners, while taking care to have good design and skilled operation in both departments, should give especial attention to the machine in the engine room and to the man in the boiler-house.

Engine Losses.

The efficiency problem in the engine-room is mainly one of installing machinery so designed and constructed as to convert the energy in the steam received from the boiler-house into the greatest measure of mechanical power, which means the least losses of heat between the steam inlet valve and the rim of the flywheel.

It has been determined that of the total heat in the fuel, something like 41 per cent. is lost in the engine. This loss is comprised, as to a very small part, of engine friction and radiation; the bulk of it is accounted for by the heat that passes away in the exhaust steam to the condenser. This latter loss is for the most part unavoidable, being due to the limited range of temperature within in which it is possible to work without resorting to expedients more costly than any economies to be effected. With an average modern engine working under good conditions, using steam at 100 deg. superheat and discharging into an efficient condenser, something like 11½ lb. of steam per indicated horse-power will be used, which means that only 25 per cent. of the heat in the steam is turned to account as mechanical power. But between the absolute minimum of loss necessitated by the nature of the case and the loss which may occur in an engine which is badly designed, constructed and maintained a considerable margin exists, and it is for the power user to reduce this margin to the lowest figure attainable. In a paper read by Mr. John Ingham before the Yorkshire Association of Textile Managers, reducible heat losses in the engine-house were classified under the following heads:

(a) Leakage of steam past valve and pistons.

(b) Cylinder condensation.

(c) Loss due to large clearance.

(d) Loss of heat between the cylinders.

Valve Leakage.

Take first the loss due to leakage past the valve. Theoretically, when the valve has closed on its seating, no steam should enter the cylinder. Practically there is great difficulty in obtaining and maintaining a steam-tight valve. Whether the valve employed be a slide, Corliss, piston, or drop valve, some leakage takes place. Further, whilst the valve might be steam-tight when tested under pressure when stationary, slight distortions are possible when working, which will cause leakage. With well-bedded valve faces in good condition, the loss will not be much, but periodical tests should be made to ensure that all valves are reasonably steam-tight. Some leakage will similarly occur past the piston. Piston rings and cylinder liners will wear, and although many ingenious devices are in use for maintaining steam-tightness under difficult conditions, tests should be made and the parts examined regularly to make sure that the steam does its work without taking a short cut past badly fitting piston rings.

The loss due to cylinder condensation depends on the range of temperature in the cylinder, or the difference between admission and exhaust, and upon the time the cylinder surfaces are subjected to the lower temperature. Consider for a moment what happens in, say, a Corliss cylinder. Steam is admitted to the cylinder, and fills the cylinder up to say, 25 per cent. of the stroke with steam at, say 480 deg. Cut-off takes place, and steam is expanded down, and, at, say ⅞ of the stroke the exhaust valve opens, and the steam passes away to the low-pressure cylinder at a reduced temperature. During the rest of the forward stroke, and up to almost the end of the return stroke, the exhaust valve remains open, and the cylinder walls are subject to the cooling effect of the low-temperature steam. Consequently on the next admission of steam a certain proportion of the heat in the steam is expended in heating up the cylinder walls. The remedy for this is to reduce the temperature range in any one cylinder or to reduce the time during which the cylinder walls are exposed to the lower temperature.

Clearance.

Another factor to which loss may be due is large clearance spaces. The most economical engines, other things being equal, are those with the least clearance. With the piston at one end of the cylinder closed, the space between the back of the pistons and the cylinder cover, and the passages from the valves to the cylinder, must be filled with steam every stroke, and although cushioning after the exhaust valve closes partly affects this, yet much new steam is wasted every stroke from this cause. Any design of cylinder which reduces the clearance space makes for steam economy.

There is, finally, the loss of heat which takes place between the cylinders in compound or triple-expansion engines. An examination of the combined diagrams from such engines reveals that material loss does occur at this stage. It can be reduced considerably by good design and care in covering, and by properly draining the connection between any two cylinders, but it can only be eliminated by allowing the whole of the expansion to take place in one cylinder. In all types of steam engines greater efficiency can be secured by close attention to these four principal sources of heat loss, but in what may be called the standard types of engine there are limiting conditions which prevent improvement beyond a certain point.

Uniflow Efficiency.

There is a type of machine, however, in which piston leakage, cylinder condensation, and clearance losses are reduced to a minimum, and between-cylinder losses are eliminated. This type, known as the uniflow type, was introduced into this country some six years ago, and has won steadily increasing recognition. Instead of exhaust valves, it has a ring of exhaust ports round the cylinder midway in its length, and as the piston reaches the end of its stroke it uncovers the port automatically, and allows a free escape of steam to the exhaust. The cylinder is much larger than in the standard design of engine, and the piston is about three times as deep as the ordinary piston . The steam cycle in the uniflow cylinder is fairly generally understood. The steam valve opens and admits steam expands in the cylinder as the piston moves formard. At a pre-determined point cut-off takes place, and the steam expands in the cylinder as the piston moves forward. When the stroke is nearly completed, the circular exhaust ports surrounding the cylinder are uncovered and the steam escapes to an annular chamber, which is cast round the cylinder ,and thence direct to the condenser. The area of the exhaust ports thus uncovered is many times greater than could be provided by any exhaust valve, and consequently the exhaust steam can be got away to the condenser rapidlv. As a matter of fact, the piston only just uncovers the open-

ings, and then closes them on its return stroke.

The period during which the cool temperature of the condenser is in touch with the cylinder walls is consequently about ⅛ of the stroke, as against ⅞ of a stroke in the ordinary form of cylinder. Compression, of course, commences immediately the ports are closed again, and is carried up to almost the initial pressure.

The heat economies in this type of cylinder are due mainly to two things; first, to reduced cylinder condensation resulting from the diminished time during which the cylinder walls are exposed to the condenser temperature, and second, to the elimination of exhaust valves and the clearance spaces which they entail.

High Vacuum Effective.

A further gain, however, results from the fact that the large area of the exhaust ports permits the bringing of a high vacuum into effective use on the cylinder. To make the most of this factor, special condensing plant must be employed. Where an adequate water supply is available, and a suitable type of condenser is used, it is possible to maintain an effective vacuum of 28 in. and even 29 in. on the piston. The uniflow type of engine has also mechanical advantages. It is simpler in construction and has fewer parts. The working friction is, consequently, less than with a cross compound engine, and a mechanical efficiency as high as 94 per cent. can be obtained. The costs of attendance, oil, repairs and insurance are correspondingly reduced; and the first cost of building and foundations is much smaller. Because of its moderate speed the engine is particularly suitable for weaving sheds, since it can be coupled direct to the main line shaft without the interposition of ropes, belts or gears. Mr. Ingham places the overall economy of such an engine and drive at from 5 to 7 per cent. higher than that obtainable from a cross compound engine.

The engine has also the same rate of steam consumption per horse-power over a fairly wide range of load, which is important in the case of mills where the load is variable or in new mills where it is necesary to have a margin of power available against future extensions. As to speed regulations, a maximum variation of 1½ per cent. has been obtained in everyday practice. This tained with first-class cross compound engines, but is quite satisfactory.

REPLACING GASOLINE WITH COAL GAS

THE use of coal gas in place of gasoline has received notable impulse in Britain recently, due to the scarcity and expense of gasoline for commercial purposes. In order to obtain definite information, the British Commercial Gas Association carried out extensive experiments which formed the basis of a report by F. W. Goodenough, which has just been published.

It is pointed out that there is no essential difference between a gas engine and a petrol engine. To convert a gas engine for use with petrol, the principal alteration needed is the addition of a carburetor, while the adaptation of gas to a petrol engine simply renders the carburetor superfluous. Petrol possesses the immense advantage of containing a large amount of energy in a small space. Coal gas, on the other hand, being for practical purposes a "perfect gas," not a vapor, conduces to clean pistons and cylinders, absence of troubles due to injector stoppages, and the complete elimination of starting difficulties in cold weather. For equal energy, however, it is very much more bulky than petrol, and herein lies the only real difficulty in connection with its use as a substitute. The gas supplies in different parts of the country not being standardized either in quality or in price, the gas obtained at some places will give a better mileage than that obtained at others; the gas equivalent, however, is unlikely ever to be higher than 300 cubic feet per gallon of petrol, but may be as low as, and even lower than, 250 cubic feet.

Flexible Gas Containers

The method of storing the gas in a flexible, balloon-like holder under a very slight pressure, probably only a few tenths of an inch head (water-gauge) above atmosphere, has several obvious advantages. The holder can be easily and cheaply replenished with gas from any ordinary supply and behaves as its own constant-pressure governor, thus obviating the need for auxiliary governing accessories; it is cheap to install and adds little or no weight to the vehicle, and there is no need for gas-compressing machinery. The practical disadvantages are the fragile nature of the holder and its bulky dimensions, which seem to unfit it for hard work in towns; nevertheless, owing to its simplicity and low cost, the system warrants careful consideration as a war measure.

From the practical engineering point of view, however, the report declares the use of gas compressed into steel cylinders to be far better, though this method must be for the future, owing to the present state of the iron market. At one time there was a considerable weight of opinion in favor of compression to 120 atmospheres (1,800 pounds per square inch), but to this there are several objections, such as the high cost of compression, the care and supervision required in dealing with cylinders stressed to this degree, the liability of the metal to more rapid "fatigue" owing to continual vibration, and the depreciation of the gas by subjection to such a high pressure. Experiments with gas stored at this extreme pressure were found to be impossible owing to the lack of the necessary material and apparatus, but experiments were made on the lines along which ultimate success will probably lie, if gas is at all practicable on a large scale, namely, the use of moderate pressures up to 20 or 25 atmospheres (300 to 375 pounds per square inch.)

There was no opportunity of determining, under present conditions, the effect on the calorific value due to compression to 20 atmospheres, but from observations made seven years ago it was found that the loss due to compression to 300 pounds per square inch was from 3 to 4 per cent., so that if due allowance be made for the difference in constitution of the gas at the present day the effect of compression would be less than 3 per cent. and probably virtually negligible. Compression to only 20 atmospheres would cause the gas to deposit 95 per cent. of its normal water contents, and, as in practice it would have very little opportunity of taking up water on its release from the storage cylinders, it would be used in a virtually dry state. The avoidance in this way of dilution by water vapor would compensate for the loss of calorific value due to deposition of hydrocarbons at 20 to 25 atmospheres' compression.

Result of Experiments

As to the nature of the hydrocarbons thrown down by compression, naphthalene will be precipitated, but observations go to show that there is always a sufficiency of liquid bodies to prevent it from assuming the solid form. These liquid bodies, however, have a tendency to polymerize, and therefore it appears desirable that containers for high-pressure gas should be fitted with drain cocks, and perhaps provision should be made for the occasional use of small hand-operated spraying device to facilitate the outflow of viscid deposits.

While there would certainly be a larger deposit of hydrocarbons at extreme pressure like 120 atmospheres, there would at the same time be greater difficulty in cleaning out the containers. It would probably be necessary to expel the deposited matter by means of heating, which would mean the dismantling of the cylinders—an expensive job. The periodical heating would also in time adversely affect the strength of the cylinders and this seems a weighty reason in addition to those already enumerated against the adoption of pressure higher than 25 atmospheres. Another point is that with 120 atmospheres the reservoirs would be smaller and the deposits greater than at 25 atmospheres, so that the volumetric capacity of the reservoirs would suffer serious diminution unless they were frequently cleaned.

Operating Weights

Figures given for several steel reservoirs show that the weights for 1,000 cubic feet of free gas vary from 1,455 pounds to 1,900 pounds for pressures of 20 to 25 atmospheres, down to 1,080 pounds for 120 atmospheres. The report states that there is reason to believe that after the war the question of weight will be found less formidable than at present, and that the weights quoted for reservoirs will be capable of reduction by 50 per cent. or more, owing to the production of steel of greater tensile strength.

Power Transmission Section

COOLING OF HIGH PRESSURE AIR COMPRESSORS

THE importance of keeping low the temperature within a compressor has already been emphasized. High temperatures are detrimental to satisfactory operation of the machine, and in addition give an increase in the work required. Special attention should be given to cooling arrangements. The best time to effect the cooling is during the actual compression, as this tends to keep the compression low near the isothermal. There are two methods of cooling during compression, namely, jacketing the cylinder and injecting water into the compressor. Regarding the latter, it is necessary to use fresh or distilled water, as any deposit would have harmful results on the cylinder bores, valves, etc.

Jacketing.—This method, although efficacious to a certain point, is only used in a few isolated cases, and the majority of machines are fitted with water jackets, which act in exactly the same way as the jackets on internal combustion engines. In high-speed machines, however, jacketing is of comparatively little value on account of the rate at which heat is generated, and as a result the compression law approximates to the adiabatic. The conditions are sometimes aggravated by a bad arrangement of valves, or thick liner flanges just where the cooling is most wanted, and these points, coupled with bad jacket circulation caused by air locks resulting from faulty design, render the cooling on some machines practically valueless as far as the work done, etc., is concerned. On the other hand, in machines designed with large clearance volumes (the low-pressure cylinder, of course, excepted) the cooling can be considerably improved by using a submerged pipe to conduct the air between the cylinder proper and the valves. This means that there is an increase in the cooling surface, and, moreover, the cooling here can be effected under the best conditions as to conductivity of the walls, etc. Not only is the air cooled during compression, but it also loses heat during re-expansion, so that the incoming air meets with comparatively cool clearance air, which condition assists in keeping low the initial compression temperature, and thereby reducing the maximum cylinder temperature.

Intercoolers.—In practice, however, as is is impossible to deliver the air directly from one stage to the next in a cool condition, it becomes necessary to resort to intercooling. Between the stages the air is passed over a suitable cooling surface, which abstracts the remaining heat resulting from the compression in the lower stage, and the air enters the next stage cylinder in a cool state, the necessity for which has been previously explained. Intercoolers may consist of a simple coiled pipe, or may be of the multitubular type—similar to a surface condenser. The coiled pipe type takes up far more space per square foot of cooling surface than the multitubular variety, unless the construction of the machine permits of the coil being placed in the jacket round the cylinders, in which case a very compact arrangement is obtained at little cost. A point with this arrangement which merits attention is the supporting of the coils. When a compressor is running at full load of, say, 1,500 lb. per square inch, a very decided "thump" can be felt on the discharge pipe with each delivery of air, resulting in excessive vibration of the pipe unless carefully stayed. In time, fracture of the pipe results, and if the coil happens to be carrying a high pressure, the effects may be considerable. Additional protection can be secured by making the coil of thicker gauge pipe, which procedure, within limits, actually improves the cooling for a given bore of tube, on account of the increased external surface.

The construction of tubular intercoolers is along similar lines to that of surface condensers, except that whereas in the latter the tubes are usually secured by ferrules, in the former they are almost invariably expanded at the ends, as the size does not warrant the more elaborate construction. Copper tubes and steel tube plates, which are unusual in condensers, are frequently used in intercoolers, the tubes varying in modern practice from ¼ in. to 1 in. outside diameter. With intercoolers the water is outside and the air flows through the tubes. Multitubular coolers are used for pressures up to about 450 lb. per square inch, and above this the submerged coil type is adopted, as necessitating fewer joints.

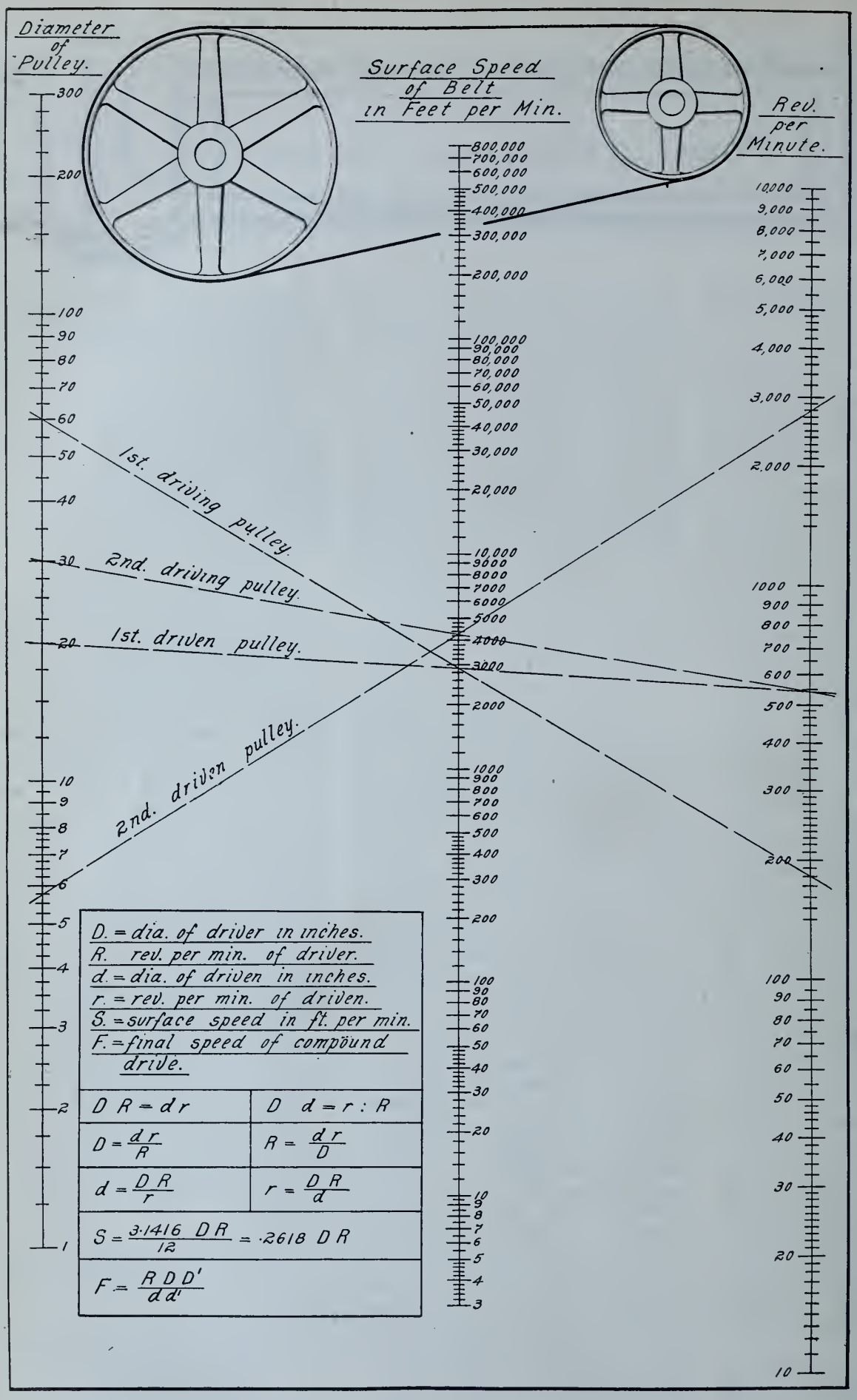
Cooling in General.—The cylinders may have jackets cast intergrally—which on account of cleaning difficulties is not to be highly recommended—or separate jackets may be used. The best arrangement is to immerse the whole of the cylinders, valve chests, connecting pipes and intercoolers in a "tank." In other designs there is always present the possibility of air pockets, or the intercoolers taking most of the water and causing the jackets proper to heat, in addition to which the inconvenience of exposed copper pipes at high temperatures is not inconsiderable. In many cases, however, the question of space prohibits the adoption of the "tank" system of cooling, and it is necessary then to jacket connecting pipes and fit valves to regulate the water supply to the various elements. For aftercoolers, a usual method adopted is to have two concentric tubes, the air passing through the central pipe and water flowing in the annulus between them.

Regulation and Control

Perhaps in no branch of mechanical engineering is there more scope for control arrangements for regulating output than with compressor work. The subject is extensive, and only an outline can be given of the several methods whereby the output of a compressor may be altered, the speed being maintained constant. The usual arrangement has for its object the maintenance of a constant delivery pressure, with varying volume output, and consists simply of suitable means for throttling the suction air and thereby altering the volume of air aspired by the machine. The effect of this on the work distribution, temperatures, etc., has already been discussed in the notes on clearance.

Another method of achieving the same object, but which only gives two definite capacities, is to arrange that the stage pressures under normal conditions shall be low, and to provide an auxiliary low-pressure cylinder, so that, when the increased output is desired, this cylinder delivers air as well as the main low-pressure cylinder. A third method is to alter the effective capacities of the various stage cylinders by adding for the time being suitable clearance volume, resulting in less air being dealt with. An advantage of the system is that the correct work distribution may be maintained at the reduced capacity. The above alterations in capacity may be effected by hand or automatically by a system of pneumatic relays controlled by the final delivery pressure.

It is assumed, of course, that the speed remains unaltered, although by changing this it is obvious that regulation can be effected. This method, however, would clearly not be permissible in a Diesel engine compressor.


Diameter of Pulley.
Surface Speed of Belt in Feet per Min.
Rev. per Minute.
1st. driving pulley.
2nd. driving pulley.
1st. driven pulley.
2nd. driven pulley.
D. = dia. of driver in inches.
R. rev. per min. of driver.
d. = dia. of driven in inches.
r. = rev. per min. of driven.
S. = surface speed in ft. per min.
F. = final speed of compound drive.
D R = d r
D d = r : R
D = d r / R
R = d r / D
d = D R / r
r = D R / d
S = 3·1416 D R / 12 = ·2618 D R
F = R D D' / d d'

TRANSMISSION SPEED DATA CHART.

TRANSMISSION SPEED DATA CHART

By J. H. R.

PRACTICAL problems involving the application of arithmetical calculations are often encountered in machine shop work. The solution of many of these apparently perplexing operations is invariably left to the foreman of the department, partly because he is responsible for that particular duty, but more often for the reason that a large number of the men under him do not, or possibly will not, acquire the necessary knowledge to perform the mental tasks that are unquestionably the foundation of the very work they are engaged in. It is a deplorable fact that a large number of workmen have neglected to retain the learning of their earlier days, when their school tasks were more of a mental than a physical character. There are also others that are unconsciously supplied with the potential requirements, but fail to see where they can make practical application of this elementary yet fundamental knowledge.

Calculations for the speeds of shafting, and the diameters of the pulleys by which the speeds are determined, are probably among the most frequent problems met with in general machine shop practice. Work of this character resolves itself down to simple proportion, or the rule of three where the equation of two ratios comprises the basis of operations. For instance, a line shaft running 200 revolutions per minute, is fitted with an 18 inch pulley and it is required to drive a countershaft at a speed of 120 rev. per

min.; what must be the diameter of pulley on the latter shaft? As pulleys derive their motion from the connecting belt it is obvious that the surface speed of coupled pulleys must always be the same (neglecting slippage). However, as the circumferences of pulleys vary directly as their diameters, it is the practice to use the latter in the calculations, therefore, as the speed of the known pulley is equal to $18 \times 3.1416 \times 200$, the diameter of the required pulley will be this value divided by the product of the speed and the constant 3.1416, or $\frac{18 \times 3.1416 \times 200}{129 \times 3.1416} = 30$ inches. It will be noticed that the value 3.1416 is common to both the numerator and the denominator, thus the practice of eliminating this factor.

The accompanying chart illustrates a convenient method of finding the various values of pulleys, shafts and belt speeds in transmission problems. The left hand column represents the diameters of pulleys in inches; the middle column indicates the belt speeds in feet per minute; and the right hand scale denotes the speed of the shaft in revolutions per minute.

To illustrate the operation of the chart we will suppose that the line shaft has a running speed of 180 rev. per min., and is fitted with a 60 inch pulley. applying a scale or fine taut thread from the points on the two outer scales, it will be found that the line intersects the middle column at the graduation between 2800 and 3000—the actual value by calculation being 2827—this being the surface speed of the belt. As the diameter of the driving pulley must necessarily determine the belt speed, it is evident that the coupled pulley will have a similar surface speed. Therefore by using the straight edge and connecting the intersection of the middle line with a certain diameter of pulley (in this case 20 inches), we find the speed of the second shaft to be 540 rev. per min. To compound this drive by using a second set of pulleys we continue as before. Connect the last found value (540 revs.) with the second driving pulley diameter, 30 inches, and through the intersection of the middle scale, connect with the final speed desired (in this particular case 2800 revs. per min.), and we at once find 5¾ inches as the diameter of the second driven pulley.

In the lower left hand corner of the chart are given the necessary data and formulae to solve for the various values. It will be noticed that the product of the speed and the diameter of a pulley on one shaft always equal the product of the speed and diameter of a pulley on another shaft, when the two are belted together. It will also be noted that the diameters are in inverse proportion to their respective speeds, that is, the smaller of a pair of coupled pulleys will always run the faster. The surface speed of the pulley, which is likewise the belt speed, can be found by using the formula, $S = \frac{3.1416\ D\ R}{12} = .2618\ D\ R$.

Example:—To find the belt speed of a drive when the driving pulley is 28 inches in diameter and running at 225 rev. per min., the solution would be $S = .2618\ D\ R = .2618 \times 28 \times 225 = 1649$ feet per minute. In a compound drive, where it is desired to find the final shaft speed and the various pulley diameters are known, also the speed of the driving shaft, the formula:— $F = \frac{R\ D\ D^1\ D^{11}}{r\ r^1\ r^{11}}$ is used. Suppose the line shaft runs at a speed of 160 revs. per min., and the driving pulleys have diameters of 36 inches, 30 inches and 20 inches, with driven pulleys of 24 inches, 18 inches and 6 inches, the resultant speed of the final shaft would be:—

$$F = \frac{R\ D\ D^1\ D^{11}}{r\ r^1\ r^{11}} = \frac{160 \times 36 \times 30 \times 20}{24 \times 18 \times 6} =$$

1333 rev. per min. nearly.

BALL BEARINGS

By C. T.

EVERY specialist whose work and effort lies in more or less narrow grooves is apt to consider that his particular specialty is of universal application. The fallacy of the position is easily realized, and much harm has been done to many good devices by irrational recommendation. The case of ball bearings is a case in point. These are decidedly not applicable in a universal sense, and their limitations are obvious to most engineers. It is impossible to utilize ball bearings in connecting rod ends; ball thrust has been tried for a steamer's thrust block, but has not met with general acceptance. It is doubtful if a ship's tunnel would prove a suitable field. The average practical man would hesitate a long time before prescribing ball bearings for a dusty atmosphere or where adverse conditions as to moisture or fumes exist.

The average ball bearing salesman is an enthusiast, the average engineer a cautious, skeptical person, and to overcome the prejudices of the latter it will need more than a mere statement or anti-frictional proof on the part of the former. The average engineer prefers stable and reliable conditions, or even something which gives limited and recurrent trouble to any alternative whose failure means a total and expensive breakdown. Ball bearings in general are not suitable for shock stress, or for heavy-running load, though for great loads under thrust conditions, such as occur in crane hooks they are admirable. In this last case, however, all the load is carried by the balls, and consequently the stress is evenly distributed.

The success of the ball bearing depends on nearly absolute refinements, sphericity of ball and perfectly hardened and polished races. Quite a small speck of grit can play the mischief, and once there is the slightest abrasion total failure is very speedy. Moreover, the specialist-made article may be wrongly applied in service, and so, through no default of the maker, be unsatisfactory. In no other manufacturing industry is the same perfection of product needed.

As a consequence, in certain locations and for certain purposes where speed and low co-efficient of friction are of the highest importance, ball bearings are the only solution. For universal consumption as a panacea for all bearing ills they have their limitations, and by reason of cost and unsuitability will never become general or replace babbit or gun-metal in a universal sense. In these days, when concurrent efforts to produce machinery producing complicated functions and to simplify mechanism as far as possible, are so greatly intensified, it is necessary to keep in mind both the uses and limitations of those triumphs of skill, the ball bearings. Also to remember that even yet much remains to be said as regards their design and manufacture, as recent discussions before the professional societies have shown.

OILING THE LINESHAFT

By A. L. Loy.

IN passing through a machine shop the writer noticed that about three feet below the main lineshaft was placed a platform about twelve inches wide. The shop was rather long, and this platform, consisting of a plank laid on brackets fastened to the building columns, extended the full length. When oiling the shaft, the oiler could traverse the entire distance without once getting to the floor, doing away entirely with the use of a ladder. The platform also came in handy in putting on or making repairs to belts. Of course, such an arrangement is possible only where the lineshaft follows the building columns.

IN the past nitric acid carboys have been closed by a loose-fitting stopper surrounded by clay or plaster of Paris, all held in place by burlap or similar material. This, says the Chemical Trades Journal, has proved very unsatisfactory, and many cases of leakage, with consequent destruction of property and injury to persons, have resulted, and it is believed that the majority of the fires in nitric acid shipments have their basic cause in defective closure. Experiments to determine practicable methods for the improvement of these conditions have been made by prominent manufacturers of acids, and when recently the situation became especially acute on account of the large increase in acid shipments, the Bureau of Explosives, with full support of the Manufacturing Chemists' Association, decided to require the use of a positive form of closure, consisting of a stopper with gasket held in place by some form of wire fastening. This is now being adopted voluntarily by the nitric acid interests, and will be recommended as a requirement of the regulations in the near future.

Steam And Its Generators

GAS EXPLOSIONS IN BOILER FURNACES.

WHEN certain conditions are fulfilled in a boiler furnace, a gas explosion of greater or less intensity will occur. For every explosion of this kind that causes material damage, there is doubtless a large number that are so unimportant that they entirely escape notice; but the fact that they do occur is well known to all persons who are familiar with the operation of steam boilers. These explosions are common to all types of boilers, and the method of setting the boilers over their furnaces appears to have little to do with the frequency or severity of them. In a general way it may be said, also, that the kind of fuel used is not the determining factor. Explosions of the gases distilled off from coal are frequent, and accidents of the same kind are far from uncommon in connection with the use of oil and natural gas for fuel. Occasionally, too, wood waste or other similarly bulky fuel which is likely to gasify rapidly is known to produce explosive gas. These explosions are likely to continue so long as fuel is burned in confined spaces such as boiler furnaces, as it is practically impossible to eliminate them entirely. It is feasible, however, to minimize the danger from them to a large extent.

Coal Burning Furnaces.

Coal being the most commonly used fuel, it follows that the greater number of explosions occur in coal-burning furnaces. The furnaces of heating apparatus are practically immune from such accidents, however, because the conditions under which they are operated are usually quite different from those that obtain in power-generating equipment, and for the further reason that, except perhaps in installations of large size, it is common to use anthracite for heating purposes, and this produces little gas as compared with bituminous coal. We recall one case, however, in which serious damage was done to a cast-iron sectional heating boiler and to the surrounding property by a gas explosion in the furnace. In this particular instance coke was the fuel used, and the explosion was so violent that the boiler was almost totally demolished, and serious personal injury would certainly have resulted also, if anybody had been in the vicinity at the time.

Gas explosions in coal-burning furnaces are chiefly due to the incomplete combustion of the fuel on the grates and of the gases in the combustion chamber, owing to an insufficient air supply. In the combustion of coal, carbon—its chief constituent — combines with the oxygen of the air which is drawn up through the grates, with the ultimate formation of a considerable quantity of carbon monoxide gas, CO, and this, when sufficiently heated, has a strong affinity for additional oxygen. Under proper operating conditions, and with an adequate supply of air, the carbon monoxide is quietly burned to carbon dioxide CO_2 in the combustion chamber, and the danger of explosion is then past. If the air is not provided in sufficient quantity, however, there will not be enough oxygen to convert the monoxide immediately into carbon dioxide; and when this condition prevails, the unconsumed but inflammable monoxide gas passes along through the furnace, combustion chamber, and tubes, and eventually up the stack still unburned.

If a considerable amount of air is admitted through the fire-doors or elsewhere above the level of the fuel bed in the furnace, the carbon monoxide in the furnace will burn quietly if the proper temperature prevails in the furnace. If, on the other hand, the temperature in the furnace is low and the fuel bed is covered with fresh coal so that immediate ignition of the gas is not assured as the air enters the furnace, then the entering air will mix with the inflammable monoxide gas, and what happens after this depends upon a number of factors. If the mixture so produced is such that the proportion of carbon monoxide to oxygen is greater or less than certain limiting percentages, then no explosion, in the true sense of the word, can occur, even upon the application of flame. There is, however, a certain critical range of proportions that the mixture may have, such that a quite serious explosion may occur if the gas is present in any considerable amount, and is fired in any way. The firing may be accomplished by stirring up the fuel bed on the grates, or by a tongue of flame coming up through black coal by which the incandescent part of the fire has been blanketed or smothered, or in other ways.

If the circulation of gases through the furnace is brisk, there is little or no chance of a gas explosion; but when the circulation has been checked by closing the damper, or throwing on large quantities of fresh coal, or in any other way, pockets of explosive gas may accumulate in the setting, and these may later give rise to an accident.

In the event of a serious explosion, the least that can be expected is that the fire-doors will be blown open and the burning fuel thrown out into the boiler-room, with the possibility of setting fire to the building. In addition, any person who may be in front of the boiler at the time is likely to be severely and perhaps fatally injured. The probability of more extensive property damage is not remote, and the boiler front and setting, and parts of the building, may show the effects of the explosion. In severe cases, too, the shock produced by the gas explosion may cause one or more of the boilers to burst. Many of the "mysterious" explosions that have occurred have very likely been due to such a cause, and in some cases it has been demonstrated that exceedingly serious explosions have been produced in this way.

Precautions Against Explosions.

To prevent such explosions, or to minimize the danger from them, it is important to regulate the air supply in such a way that complete combustion of the fuel and of the gases derived from it will take place when operating conditions are normal, and to assist the combustion or to remove the gases in a safe manner when unusual conditions prevail.

Normally, with a well-designed boiler installation, the draft, either natural or artificial, prevents the accumulation of pockets of explosive gases, but the danger arises when this circulation is checked by banking the fires, or by running them low when only a small amount of steam is required. At such times, therefore, special caution is necessary. Careful preparation of the fires is important, before banking them. Clean the fires and remove the ashes a short time before shutting down the boilers, and then allow the fires to burn up evenly over the entire surface of the grates, seeing that the fuel bed is leveled to an approximately uniform thickness. Next apply the banking fuel, taking care that this is also spread on uniformly and in sufficient quantity.

As a rule, the dampers in the uptakes of boilers are perforated or slotted so that there will be a slight draft through them even when they are in the "fully-closed" position. If such provision is lacking, however, the dampers should be

left partly open, and usually the explosive gases will then pass out through the chimney, because they are somewhat lighter than the air, and are first to feel the influence of the draft. Under certain conditions, these gases may be by-passed to the stack, and if the by-passes are correctly proportioned the loss in boiler efficiency, even under operating conditions, will be inconsequential. A by-pass of this kind is particularly important in connection with a boiler in which the gases between the combustion chamber and the stack follow a downward direction during any part of their travel.

As a further safety measure, the dampers and fire-doors should be opened in the morning before the fires are broken up, so that any gases that may have accumulated during the night will be swept out of the setting

Safety fire-doors have been designed for the protection of the firemen and others against the showers of burning fuel that are sometimes projected from the furnaces by gas explosions. In some types the doors slide in guides, sidewise or vertically, instead of swinging on hinges. Sometimes, too, the doors are hinged so that they swing into the furnace, instead of outwardly into the fire-room; and in other cases ordinary doors are provided with special safety catches. A practical device of some one of these types is recommended for use in cases where gas explosions are common.

Oil or Gas Fuel Furnaces

The likelihood of having gas explosions is especially pronounced when either oil or gas is used for fuel, unless the fireman is an exceedingly careful person. In lighting the fire in such cases, burning cotton waste or a burning torch or some other kind should be placed in the furnace before the fuel-supply valve is opened. In this way the fuel will be ignited at once, and before any explosive vapors or gases can accumulate in the furnace. If a burner should become extinguished (or "snap out"), while the boiler is in operation, because of water in the oil, or on account of temporary stoppage of the fuel supply, or for any other reason the supply valve should be closed at once; and the furnace and all of the gas passages should be ventilated thoroughly before again lighting the fire.

Various special precautions against gas explosions may be required when forced or induced draft is employed, and in such cases the judgment and skill of the engineer in charge may be severely taxed to provide a remedy without sacrificing something of the efficiency of the boiler, because in boilers of ordinary design the maximum efficiency is usually obtained with a comparatively low velocity of the products of combustion, while the prevention of gas explosions depends largely upon maintaining a fairly rapid circulation. A way may usually be found to overcome these difficulties, however, and safety demands that earnest and consistent efforts be made to arrive at a proper solution of the problem.

MOTIVE POWER FOR SMALL USERS

By C. T.

THE question of the best motive power for small users, as determined by the use of steam, gas or electricity, is one that can only be answered by a full knowledge of the circumstances existing in each particular case. In a case which was considered recently, where duplicate power was absolutely necessary, where the user had two engines and two boilers, one of each being always at rest, but ready to be started at a moment's emergency, the question was raised, when one of the engines had worn out, whether another engine should be installed or whether gas or electricity should be requisitioned as the motive power. It was ultimately decided that in this particular case another steam engine should be purchased on account of the large capital outlay that would be involved in converting to electricity, gas being quite out of the question. Later, a consulting engineer, who had been asked for an opinion on this problem, recommended that, as additional plant was put in, each machine should have its own motor, and in the case of replacements the same course should be adopted, and when replacement had reached a certain point the older machine should be scrapped and a dynamo put in as a stand-by in case of failure of the electric supply. The advice proved correct, and it shows the advantage of power users going to the expense of getting expert opinion before deciding on the course to be adopted. It is difficult to lay down a hard-and-fast rule for application in every case, but it is possible for steam plant to be scrapped long before it is worn out, and the resulting saving has been so small that it has meant a capital loss.

DEVELOPMENT OF OXYGEN MANUFACTURE

By J. W. G.

THE use of oxygen in connection with welding processes, carbon removal from engine cylinders, etc., has become such a commonplace matter in the ordinary routine of manufacturing activities that little or no thought is ever given to the processes whereby this now indispensable gas is separated and prepared for use.

The commercial production of oxygen dates from the year 1886, in which year operations were commenced by an English concern to develop a process invented by two Frenchmen, the Brin brothers, their process being based on previous discovery by Boussingault in 1851, that barium monoxide absorbs oxygen from the atmosphere when it is heated to 1,000 deg. F., and gives it up again when the temperature is raised to 1,600 deg. F. This cycle of operations was repeated indefinitely, the barium monoxide remaining unaffected by the alternate heating and cooling.

Despite the lapse of time from the original discovery of the process, many practical difficulties still remained until Brin's Oxygen Co. succeeded in developing the manufacture to such a high degree of perfection, that the barium process maintained its superiority against all efforts to develop other processes of obtaining oxygen on a commercial scale.

The commercial liquefaction of air had meanwhile been developed by Prof. Linde of Munich, in 1895, and from that time on the ultimate eclipse of the barium process became more and more a matter of time. The actual process of obtaining oxygen through liquefying air is a highly specialized proceeding and its success has been very complete, the barium process being entirely discarded, although the possibilities of electrolytic cells are the subject of intense experiment and research by interests allied with electric power supply companies, and developments in this direction are pending.

Despite the decadence of the original process, it is gratifying to know, especially at this time that oxygen production in Germany, France and United States was first put on a commercial basis with barium plants designed and erected by the original Brins' Oxygen Co.

LARGE CHIMNEYS UNDER CONSTRUCTION

WHAT will be the largest chimneys in the world, when completed, are being constructed by the Alphons Custodis Chimney Construction Co. of New York. One of these chimneys, which is being built at Tacoma, Wash., for the Tacoma Smelting Co., has the following general dimensions.: Height above ground, 571 feet; inside diameter at top, 25 feet, and outside diameter at base, 50 feet 2 in. The other chimney, which is being constructed for the Anaconda Copper Co., Anaconda, Mont., will have the following dimensions: Height above ground, 525 feet; inside diameter at top, 60 feet, and outside diameter at base, 86 feet. The chimney at Tacoma when completed will be the tallest in the world, and that at Anaconda the largest in diameter.

The largest diameter chimney in existence at the present time was built in 1908 by the same concern for the Boston & Montana Copper Co., at Great Falls, Mont. It is 506 feet high and 50 feet inside diameter. These chimneys are built of special radial brick; some examples of this construction in Canada may be seen at the Toronto Carpet Mfg. Co., the Municipal Incinerator, Toronto, and the Goodyear Tire & Rubber Co. of Canada, Ltd., New Toronto, Ont.

On the subject of aluminum pistons for internal combustion engines, Joseph Leopold, an American engineer with much experience of this class of work, advocates a plain-sided piston of normal length, with circumferential grooves in the skirt, as distinct from the hour-glass or narrow-waisted type. It has only two rings above the gudgeon pin, the lower one having its groove bevelled and the bevel drilled through to the interior. A third ring is provided at the bottom end of the skirt.

REFRIGERATION DEPARTMENT

RAW WATER ICE AND POWER FOR SAME

By J. B. M.

I AM going to try to present the question of raw water ice manufacture in a few words from the standpoint of my experience and allow each one to judge what best meets his requirements. The first question that arises in the minds of the ice manufacturer are the cost of installation, cost of manufacturing and quality of product.

The cost of installation will depend entirely upon the type of power used to operate, so I am unable to give you any definite figures, but will have to allow each of you who are considering the manufacture of raw water ice to take this matter up and investigate for yourselves, but using either oil engine drive or gas engine drive, your investment will be, roughly, 40 per cent. for a complete plant in excess of the cost of installation of distilled water plants.

From the standpoint of cost of operation, fuel cost is a large factor, and worth serious consideration; in fact, from a standpoint of cost operation, there is no economy in the operation of a raw water plant, except such economy as can be realized from the use of cheaper power than steam, regardless of any claims that may be set up by salesmen, based on my experience. You can use for power on raw water plant, water power, steam power, electric power, oil engines or gas engines, or, in fact, any old power. You are all familiar with steam and electricity, and, of course, where electricity can be obtained at a price ranging from one-half cent to one cent per k.w. hour, it is worth serious consideration, as you can eliminate firemen and install your plant from a standpoint of power, for about 20 per cent. initial cost of what it would cost you to install a gas producer and gas engine. As to steam, if I were located so that it was economical to use steam power, I would operate a distilled water plant, as, in my judgment, you would not be justified in putting the necessary investment in tanks and general equipment for making raw water ice for the sake of the quality, generally speaking.

As to gas producers and gas engines, I believe these have been developed to the point where we can class them as a whole as satisfactory, and the cheapest power obtainable. with the exception of water power. Especially is this true where you have a constant load and can operate continuously. The nearer to continuous operation you have the more economical this class of power is. I have seen a great many in operation of different makes, in different sections of the country. One I recall having seen that was claimed to have been in operation twelve years and still giving good service 24 hours a day. I am interested in three companies, using producer gas engines. One of these plants is operated on bituminous coal, one on anthracite coal, and one on city gas. All of these are giving very satisfactory service and producing ice at a fuel cost of less than fifty per cent. of my usual fuel cost on steam plants. This economy, with coal at $3.50 per ton, will amount to about 40 cents per ton of ice produced, on an average. This saving, however, can be greatly increased if we figure the present market price of coal, and there is still a greater saving to be obtained where one is able to get nearer a continuous operation than I have. On a continuous operation, I have produced as high as 27 tons of ice on one ton of coal.

In addition to operating all auxiliaries, including electric generator, air compressors, etc., the great disadvantage I find is in the fact that you have to carry fires in your producers constantly, regardless of whether you are operating or not, which, of course, with the ordinary ice manufacturer, brings his average fuel cost up pretty heavy, as compared with what it would be provided he had a constant operation, as the consumption of coal, standing, is about 75 per cent. as much as though you were operating, provided you operate your plant at all. If the price of coal continues to soar, or even remains at present high prices. the savings will be much greater and force the more serious consideration of power cheaper than steam.

Gas Engine Experience

I make reference here to gas engines, for what it is worth, as I have had more experience with them than with any other power except steam. One thing I especially want to call your attention to in connection with gas engines, viz., that it is necessary to operate them at a high rate of speed and regardless of the claims of some manufacturers that they can satisfactorily connect direct large size compressors or even small size compressors. I was foolish enough to allow one machinery manufacturer to talk me into installing a 75-ton ice making compressor, direct-connected to a gas engine. This compressor was operated at a speed of 205 r.p.m. and gave me no end of trouble, mainly, in my judgment, for the reason that gas engines are built with three cylinders and vertical compressors with two cylinders, and it is impossible to time the stroke of the three cylinders on the gas engine with the two cylinders on the ammonia compressor.

As a result, with every revolution, there is a certain amount of slack in any coupling that can be installed, so that you continuously break either the coupling, or, if the coupling is strong enough to withstand the continuous pound, then the shafting or something else is going to break. Fortunately, I was covered by sufficient guarantees in my purchase and the machinery manufacturers have taken out this particular compressor and are installing a slow speed machine, to be belt driven and, in view of the fact that I am interested in two other plants and have observed numerous others where belt drive is used, I do not anticipate any further trouble, and my advice is, regardless of what power you use, use comparatively slow speed compressors, especially of large size.

Water Available for Product

Now, as to the product, or raw water ice, this is absolutely dependent upon the kind of water available. If any of you are considering putting in raw water plants, by all means do not spare expense or trouble in absolutely determining what your water will do, before tying yourself up on machinery. Almost any soft water will make satisfactory raw water ice. The softer the water the better. Some hard water can be treated chemically, but this usually requires additional expensive tanks and other apparatus for handling, and even then is very often unsatisfactory. Where the water is good for the purpose, you can, by pumping cores, make beautiful ice, in that it is absolutely tasteless and superior in appearance, to the usual distilled water ice, and equally as pure. I do not believe you can make perfect raw water ice without pumping cores. The refilling of the cores can be done with distilled water, if available, and oftentimes adds a little to the appearance of your ice, and your exhaust from either gas or oil engines can be used for evaporating enough steam to give you distilled water to fill cores if desirable. As to the advisability of this, it all depends upon the quality of your water.

I have observed that there is an inclination on the part of some distilled water ice manufacturers to condemn ice made on raw water plants. This is all right, of course, so long as raw water ice does not come into immediate compe-

*From paper read at joint convention of Eastern Ice Association and Middle States Ice Producers' Exchange.

tition, but if it does you should go slow in your criticism. Understand, I am not especially a raw water man, I am interested in four distilled water plants and three raw water can plants, and if I were going to put in additional plants the type of plant I should install would depend altogether on local conditions. There is no doubt but what you, normally, can manufacture raw water ice for less than distilled. The investment per ton, however, is considerably more, so that by the time you consider interest on the additional investment, and additional depreciation, it would average about the same net cost per ton of ice manufactured with coal at normal prices. This being true, the difference between the two is sifted down to the quality of the product, and, in my opinion, with good soft water, raw water ice has the advantage over the distilled.

PRINCIPLE OF MECHANICAL REFRIGERATION

MECHANICAL refrigeration is based upon the condition of certain gases, which, when put under pressure, becomes like water, provided the heat which is developed during compression is extracted. When this pressure is taken off or reduced and the heat returned, the liquid will return to its former condition, namely, gas. If the heat is not immediately returned, it will remain a liquid at the reduced temperature, until it has absorbed from the surrounding bodies all the heat which it requires to bring it back to its gaseous state. Of all gases, the one best adapted for mechanical refrigeration, and which so far has given the best results, is anhydrous ammonia. The pressure required to turn it into a liquid is not very high, about 175 lbs. to the square inch, and the temperature to which it lowers itself when the pressure is reduced to about 15 lbs. is about 40 deg. Fah. below zero. Anhydrous ammonia, or, in fact, any other volatile gas, is expensive; therefore, it is not allowed to go to waste after it has once done its work, all refrigerating machinery being so constructed that the gas is kept in hermetically sealed pipes, and made to do the work through these over and over again.

To indicate briefly the principle of mechanical refrigeration, there is shown herewith a complete refrigerating plant, in diagram form. In following the direction of the arrows it will be seen that the volatile gas passes through a continuous circular process. It will be noticed that the compressor on one side is connected to a refrigerator, and on the other side to a condenser. In the refrigerator the volatile gas, say, ammonia, is kept under a low pressure of about 15 lbs. per square inch, and in the condenser under a higher pressure of about 175 lbs. The compressor pumps the gas out of the refrigerator and delivers it into the condenser. If we start from the compressor, where the ammonia gas is compressed to the pressure required for its liquefaction, say, 175 lbs. per square inch, the compressed but heated gas is delivered into the condenser, consisting of hermetically sealed pipes. Here the compressed gas gets cooled by means of water surrounding the pipes, and after it has been sufficiently cooled, falls down to the bottom of the coil as a liquid. From here the liquid ammonia is passed through a regulating valve into the refrigerator, also consisting of hermetically sealed pipes.

The regulating valve is required in the first place to allow the pressure to be kept in the condenser; and, secondly, to let only so much liquid ammonia pass into the refrigerator as can properly evaporate when passing through the coils. When passing through the regulating valve, the liquid ammonia is suddenly reduced from the high pressure in the condenser to the lower pressure in the evaporator. As in the short time in which the liquid ammonia passes through the valve it cannot absorb any heat, the liquid ammonia reduces its own temperature down to about 40 deg. Fah. below zero. By letting it, at this low temperature, pass slowly through the refrigerator pipes it is given time to absorb from the surrounding air or brine all the heat it requires for its evaporation, and in return cool same.

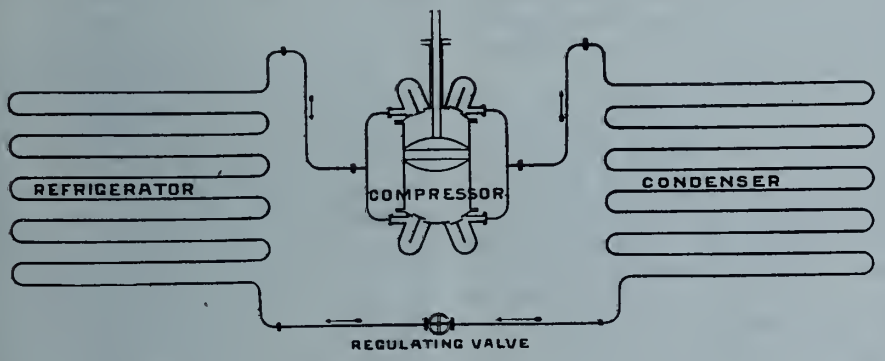


DIAGRAM SHOWING PRINCIPLE O F MECHANICAL REFRIGERATION.

After the liquid ammonia is evaporated—that is, formed into gas, the gas is drawn back by the compressor, is again compressed and delivered into the condenser and liquefied, from whence it again passes into the refrigerator and back to the compressor, and so on indefinitely.

A refrigerator plant, therefore, must always consist of three principal parts: A compressor; a liquefier or condenser; an evaporator or refrigerator.

These three parts cannot work separately, or one without the other, and if one is lacking in construction or capacity, the other two suffer, and cannot make up for the loss. "The strength of a chain is its weakest link" is an axiom that can be well applied to a refrigerating plant, for if one of the three principal parts is weak in construction or design, the other two cannot make it strong, and, therefore, the whole plant is weak. This should always be carefully considered before buying refrigerating machinery, as on the design and construction of the different parts depend the success and efficient working of the refrigerating plant.

THE BEGINNING OF MECHANICAL REFRIGERATION

THE original air refrigerating machine was brought out in 1845 by Dr. Gorrie, of New Orleans, who with Dr. Cullen felt a special need of artificial refrigeration in the aid of his profession. This mechanism had a cylinder in which the air was first compressed. It was passed from this cylinder to a chamber cooled by running water where a pressure of fifteen pounds per square inch above that of the atmosphere was maintained. The air was already cooled partly during compression by the injection of water, the cooling chamber receiving in reality a mixture of air and water. This on passing to another cylinder was expanded down to something like atmospheric pressure. While expanding it was mixed with brine injected into the cylinder, the low temperature of the expanding air communicating itself to the brine. The air on leaving this cylinder was allowed to escape to the atmosphere while the brine, now cooled to 20 deg. F., was conveyed into a tank and applied to ice making.—Edison Monthly.

SEEKING to imitate klingerite, a German packing for steam-pipe joints, French chemists have found a specimen of the material about a sixth of an inch thick to consist of fifteen thicknesses of thin asbestos, says the Chemical Trade Journal. These layers were a compact felting of the best long fibres, mixed with 2 per cent. of flax threads to give strength and pliability, and each side was coated with an agglutinant containing sulphur, designed, it is supposed to increase impermeability and resistance by slow vulcanisation. Analysis showed 80.5 per cent. of asbestos, 2.2 of cellulose (flax), and 17 of rubber and balata, with a small proportion of sulphur.

THE demonstrated advantages of electric motor drive as applied to steel mill-service are rapidly making its use universal in rolling mill work, while as regards reversing mills, substantial evidence of the exceptional superiority of electric drive has been given during the past two years. Less than two years ago there were two electrically-driven reversing mills operating in the United States and one in Canada. In November-1916, there were fifteen mills of this type either in operation or being constructed, whilst in Britain, according to the "British Westinghouse Gazette," there were two.

Electricity and Hydraulics

COMMUTATOR TROUBLES

By A. V. Burr.

ELECTRICAL machines of the commutator type should be given close attention by the operator, especially in regard to the proper operation of the commutator and brushes. It is here that any faults of the machine usually manifest themselves, and any unusual symptoms of impending trouble should be the signal for locating and remedying that trouble as soon as possible, else conditions will soon go from bad to worse and finally result in the total disabling of the machine or necessitate an expensive repair job.

The complicated mechanical structure of the commutator also is a source of inherent weakness, which may develop and hinder it from performing its electrical function in the required manner, with the result that extra duty may be imposed on some parts from others, heating occurs and both commutator and brushes suffer to the deterioration of the machine.

Thus no commutating machine is operating satisfactorily when the following conditions are apparent: (a) sparking at the commutator, (b) noisy operation.

As there are various causes which may be responsible or contribute to the above undesirable conditions, it is hoped that the following arrangement of cause, effect and remedy, may be of assistance to the operator in securing the best possible performance.

In locating the cause of any trouble, mechanical inspection should at first be resorted to and if this fails to reveal the defect, it may be inferred it depends on some faulty electrical condition. Therefore, in ennumerating the various causes they are classified from their mechanical and electrical standpoints and we will first consider those pertaining to sparking.

Mechanical Points

(1) Displaced Commutator Bars: Large commutators with their great number of relatively thin segments and subject to high centrifugal forces, are very apt to undergo some displacement of the bars and a gradual readjustment during their first stages of operation. Symptom: The brushes may be broken or split, and will likely chatter and be abnormally hot. Remedy: Until a permanent condition is reached, the commutator should be tightened, if loose, and trued up from time to time. To do this with small machines, the armature is taken out and turned off in a lathe. With large machines or those of the engine type, mounted on engine shafts, the commutator is either turned off with a lathe tool, or trued off with a grinding tool, with the armature in place in the machine. In the first case a device with a movable tool post is clamped to a stationary part of the machine, the commutator is revolved at the proper cutting speed, and light cuts made across the work. In the second case the commutator revolves at normal speed, while the rotating grinding wheel is moved across the face of the commutator. This form of device is shown in Fig. 1.

(2) Eccentric Condition: The commutator may run out of true due to a bent shaft, spring in shaft from engine thrust or looseness in the bearing. It may also become distorted by being overheated. Symptom: Careful examination shows a rise and fall of the brushes when the commutator turns slowly. The brushes will chatter when running fast. Remedy: If the eccentricity cannot be overcome by remedving these defects turning off or grinding at normal speed should be resorted to.

(3) Mechanical Vibration. This may be evident in machines operated at high speed as turbine driven units, motor generator sets. It denotes either unbalanced rotor or loose commutator, a had belt. or unsteady foundations. Symptom: Considerable vibration is felt when the hand is placed upon the machine and sparking decreases if the vibration is reduced. Remedy: The machine must be re-balanced, either by balancing weights or pouring melted lead into pockets usually provided for that purpose. If a loose commutator is the cause, tighten up the bolts in the clamping rings.

(4) High Mica: This condition most frequently appears in large commutators having a relatively large number of thin commutator bars, where the percentage of mica is high relative to the copper. It shows that the copper is wearing faster than the mica. The use of soft carbon brushes, which though excellent for commutation purposes, are deficient in abrasive material, is usually responsible for high mica. Symptom: The projecting mica, be it ever so slight, can be detected by mechanical inspection. While running, fine pin sparks occur between the faces of the brushes and the commutator, which becomes blackened and burned. Remedy: Special machines are made for the purpose of undercutting the mica to a depth not exceeding 1-16 in. The slot should not be less than 1-32 in. wide so as not to harbor dirt. As a rule the centrifugal forces at this point are sufficient to throw out any ordinary accumulations of dirt.

(5) Dirty Commutator: One objection to undercutting is that material may accumulate in the slots, which with carbon and copper dust will form a conductor between adjacent bars. Dirt and oily dust is also likely to accumulate at the inner and outer corners where the brushes do not touch. Symptom: Such a condition is often the cause for sparking at the end of the commutator flashing and arcing over. Remedy: Make slot inspection and cleaning a part of the regular care of the machine. The end of the commutator should be thoroughly cleaned, and then painted with good insulating varnish, and repainted as often as necessary. The outer and inner corners should be slightly rounded as shown in Fig. II (about 1-16 in. radius).

(6) Pitting of Mica: It is generally considered that the pitting, or eating out, of the mica between the commutator bars, starts from some form of dirt getting in or onto the mica segments. This dirt is more or less of a conductor and the current carried by it, due to the voltage between bars. may sooner or later carbonize the mica so it in turn becomes a conductor. This carbonizing process goes on until holes of considerable size are sometimes produced in the mica. Oil is a common vehicle for transmitting or holding the dirt and care should be taken to see that no oil gets to the commutator by spraying, creepage, etc. Symptom: Burnt spots appear in the mica. Arcing occurs between bars when the current is put on. Remedy: Pick out all the burned particles and then fill the holes up with some form of high grade cement. That used by dentists is very good. Plaster of Paris with sufficient shellac for a bond may also be used. The filling material should be allowed to set thoroughly before the machine is used.

Electrical Points

(1). Wrong Brush Position:—The brushes may not have the proper lead, forward or backward from the neutral position to ensure sparkless commutation. Or the arms carrying the brushes may not be uniformly spaced around the commutator as a result of which some brushes may have the right lead and some the wrong lead. This does not ap-

ply to machines with commutating poles. Sympton:—Bad sparking as the commutator leaves the brush. Remedy:—Shift the brushes or replace the brush arms properly.

(2). Excessive Current.—Sometimes a sudden and very heavy overload such as a short circuit on the line, will cause the current to "bite" into the copper at certain points and leave a condition of roughness. Again a flash over will leave a flat spot on the commutator which will need to be taken out to prevent burning.

Symptom:—Roughness first appears on a few bars at intervals around the commutator. The conditions unless removed tends to get worse and spread around the commutator because it sets up destructive sparking. Remedy:—Smooth the commutator with a fine file or fine sandpaper which should be applied on a block of wood that exactly fits the curvature of the commutator. Be careful to remove any grit particles that remain and never use emery. A block of sandstone used for the purpose is better than sandpaper because of its unyielding nature it shears off the mica at the same rate as it does the copper and leaves the commutator perfectly smooth. The sandpaper or sandstone block is applied while the machine is turning over but without load or voltage. During the smoothing process the brushes should be lifted off the commutator to prevent them from accumulating copper dust.

(3). Brush Conditions.—Anything that causes poor brush contact at one part of the commutator throws an excess current to the other brushes of the same polarity, thereby causing them to be overloaded. Symptom: An overloaded brush may be detected by sparking, by glowing in which spots are heated to incandescence, or by honeycombing in which spots on the face of the brush appear to be eaten out, or by picking up copper where the copper appears to be deposited electrolytically in spots on the face of the brush. Honeycombing often starts at these spots of copper due to the localizing of the current. Remedy: Correct any roughness or eccentricity of the commutator. See that no brushes are clogged in their holders and that they bear with equal pressure on the commutator. The amount of tension to apply must suit the circumstances. Notice whether the commutator is worn in edges causing the brushes to ride up and down as the armature shaft moves back and forth in its bearing. This can be prevented by "staggering" the brushes so that the bearing surfaces in the different sets will overlap. Repair any bad contacts in the shunt connections between the brush and holder. A change in the grade of brush will sometimes improve operation where other things fail.

(4). Armature Condition.—An open circuit in the rotor winding, a bad joint in the winding or a short circuit will cause burning which will start at the bars connected to the defective coils. Symptom: The open circuit will make itself evident by sparking at the brushes. With a bad joint, the sparking may not be so much in evidence, but a gradual blackening of the bars will take place. The short circuited coil will roast out and be liable to damage adjacent coils. Remedy: Repair as soon as possible. In the case of the short circuited coil an emergency repair may be made cutting one of the commutator leads to this coil and attaching a jumper across the commutator bars to which the coil is attached.

(5) Field Conditions: Any conditions which may tend to weaken the field such as high speed or low operating voltage will result in the shifting of the point of commutation with change of load. Symptom: Intermittent sparking with change of load. Remedy: The trouble may be stopped by decreasing the load, shifting the brushes as the load varies, reducing the speed or raising the voltage.

(b) Noisy Operation

This condition indicates a faulty contact between the brushes and commutator through one or any of the following causes: (1) Dry Surface: A dry contact surface will usually cause "squealing" or "chattering" of the brushes. Remedy: It is stopped by using a different grade of brush with better lubricating qualities or simpler still, an occasional application of a small amount of clean oil, except in cases where the mica is undercut when it is not advisable to use oil. Never apply the oil with a cloth or any material having a loose fibre that will cling to the surface and get under the brushes. For this reason cotton waste is a poor material to use. Heavy canvas or a short length of tightly woven cotton hose is good.

(2) Angle of Brushes: The tendency in brushes to chatter may sometimes require the changing the angle of the brush or the relation of the angle to the direction of rotation.

(3) Brushes Loose in Holders: In brush holders of the box type a loose fit may allow the brush to vibrate or chatter. An easy sliding fit is best.

(4) Unevenness of Commutator or Brush Surfaces: Noisy operation is sometimes occasioned by some unevenness of the commutator which strikes the brush a small hammer blow at every revolution. In high speed machines this may be sufficient to split and break the brush.

The face of the brush should have the same curvature as the commutator and be ground to a good fit. Carbon brushes can be fitted perfectly by drawing a strip of sandpaper back and forth between them and the commutator while they are pressing down.

A commutator in normal operation soon acquires a rich bronze glaze or polish and constant vigilance is necessary to maintain it in this state so greatly to be desired.

TUNGSTEN LIGHTING

By B. P. H.

THE subject of illumination is one which concerns everyone in general, but the industrial man in particular. He is dependent to some extent upon artificial lighting during a percentage of the working hours and the quality and effectiveness of the lighting has a direct influence on his results. It is presumed therefore, that a repetition of some elementary rules governing the design and installation of tungsten lighting will be of interest.

The purpose of illumination is to provide a certain needed intensity of light and uniform distribution over an area which is called the working plane.

In any location which it is required to light, the character of the work carried on determines the intensity in foot candles required on the working plane. With this as a working basis every theoretical problem of illumination then resolves itself into a determination of the proper size and arrangement of lamps and reflectors with reference to the working plane, to secure the required intensity and uniformity.

Preliminary Design

With so much excellent data available based on past experience in typical installations, it is a simple matter to choose those empirical values for the different factors such as size of lamp, mounting height and spacing distance, etc., as would seem to fit the circumstances. Thus tables I, II and III present some average co-relations of the different items which have approved themselves in service and which can be accepted as a guide in the design.

It is apparent that for low ceilings the lamps must be fairly close to avoid unsatisfactory shadow effects and therefore the size of lamps should be small and vice versa for high ceilings.

The height and type of ceiling must be considered in the choice of mounting height. As a general rule it is best to mount the lamps within a foot or two of the ceiling as they are then out of the way and less likely to be broken, while the arrangement also makes for freedom from glare and annoying shadows. Besides the light thus transmitted to the ceiling through the reflectors is better diffused and imports a cheerful overhead aspect.

But in cases where the ceiling is broken up by girders or where overhead belting, line shafting or other obstructions will obscure the light it is necessary to lower the mounting and hence use a smaller size lamp over the area affected. Lamps of the same size should always be hung on the same level.

It has been assumed from the study of different installations that the efficiency of a typical shop lighting system based on the average performance of tungsten lights using glass reflectors is around 25%; that is, roughly speaking, one quarter of the total light generated by the lamp is received on the working plane. From this and data supplied by

the lamp manufacturers, it may be deduced that an illumination of one foot candle is given by a lighting intensity of ½ watt per sq. foot and table I has been prepared, using this conversion factor.

TABLE I.

Class of Work—	Foot Candles	Watts per Square ft.
Average manufacturing	3	1.5
Average office	3.5	1.7
Power house	2.0	1.0
Inspection	5.0	2.5
Corridors	1.0	0.5

TABLE II.

Mounting Height, Ft.—	Size of Lamp Watts
7 to 10	40
8 to 12	60
10 to 14	80
12 to 16	100
14 to 20	150
17 to 27	250
25 to 35	400
30 to 40	500

It is obvious that something of a more exact nature than tables II and III is necessary in the practical design, if we are to secure the anticipated intensity of illumination. The following calculations will serve as a check:

Select the size of lamp from table II and the watts per sq. foot from table I. Divide the wattage of the lamp by the watts per sq. foot to give the area of the square in sq. feet of which the lamp is the centre. The square root of this figure will obtain the side of the square in feet or the ideal spacing distance between the lamps, since the lamps are arranged on the square to provide the best distribution of light throughout the location.

W=wattage of lamp. w=watts per sq. foot.

A= area of square. d—ideal spacing distance.

$$d=\sqrt{A}=\sqrt{\frac{W}{w}}$$

Reflectors

As the whole design hinges on the selection of "watts per sq.foot," which in turn, as has been shown, is dependent on the assumed efficiency of the system, it should be remembered that values for the latter change with every condition of ceiling and wall reflection, also with the type of reflector used and the accumulation of dust and dirt on the reflectors and globes. To allow for conditions, a variation up to 15% above and below the given figure for "watts per sq. ft." in table I may be allowed, depending on whether the surroundings are dark or light.

Having fixed on the spacing and mounting conditions of the lamp, the next thing is to choose a suitable reflector from the large variety available. Clear prismatic reflectors are designed for a given ratio of spacing distance to mounting height and may be recommended as having the maximum efficiency and being the easiest to install.

Practical Design

For designing the layout to fit the area and shape of the particular location, some leeway must be allowed in the item of spacing distance so as to avoid any obstacles, such as columns, etc., which might interfere with the placing of the lamp and the shedding of its rays on the working plane. Before hanging the lamps preliminary sketches of plan and elevation should be drawn to scale, showing the location of roof trusses, beams, columns or other obstacles which may affect the installation, also the position of windows, and if previously wired, the present outlets, conduits and switches.

The first row of lamps may then be laid out on the plan, either with reference to the required proximity to the neighboring wall or with a view to effecting economy by using a part of the old system of wiring and outlets. A good practice is to place a row of lamps within 2 ft. 9 in. of the side walls.

TABLE III.

Mounting height, ft.	8	10	12	14	16	18	20	24
Spacing distance, ft.	8	8-10	8-12	8-14	8-16	10-16	10-18	10-20

Different spacing distances can then be tried out until a satisfactory design is completed which evades all obstacles and provides regular spacing, approximating as near as possible the ideal spacing distance. The allowable variation of the spacing distance in the two directions should not exceed 25% of the ideal as shown in composite table IV.

TABLE IV.

Size of Lamp W	Mounting Height	Watts per Sq. ft. w	Ideal Spacing Distance $\sqrt{\frac{W}{w}}$	Min. Spacing Distance	Max. Spacing Distance
Watts	Feet	Watts	Feet	Feet	Feet
		.5	9.0	8.0	10.0
40	7–10	1.5	5.2	4.6	6.0
		2.5	4.0	3.9	4.3
		.5	11.0	9.6	12.9
60	8–12	1.5	6.4	5.6	7.3
		2.5	4.11	4.6	5.6
		.5	12.7	10.6	15.0
80	10–14	1.5	7.4	6.6	8.3
		2.5	5.8	5.0	6.6
		.5	14.5	12.6	16.0
100	12–16	1.5	8.2	6.6	9.6
		2.5	6.4	5.8	7.0
		.5	17.4	15.0	20.0
150	14–20	1.5	10.0	9.0	11.0
		2.5	7.9	7.0	8.6
		.5	22.5	20.0	25.0
250	17–27	1.5	12.11	11.9	14.3
		2.5	10.0	9.0	11.0
		.5	28.2	25.0	31.6
400	25–35	1.5	16.4	15.0	17.9
		2.5	12.7	11.6	13.6
		.5	31.7	28.0	35.6
500	30–40	1.5	18.6	16.6	20.9
		2.5	14.2	12.6	15.0

Specifications

Finally for the convenience of the wiremen make a dimensioned tracing, showing boundary of area, the number of lamps and their position, the grouping of lamps controlled by the same switch and the position of old outlets and switching, if any, which might be utilized to reduce the cost. Flexibility in control also makes for economy by wiring lamps near windows to the same switch, as also lamps extensively used at different times from others.

Estimates

The specifications being completed it is left for the wiremen to pencil in all circuits, to measure up the amount of wire required, to prepare a complete bill of material for the work and to estimate the cost of the installation.

This estimated cost of installation per lamp when compared with the cost in other or similar locations will indicate whether or not the installation cost is excessive. To reduce the cost would require that a lower value of "watts per sq. foot" be chosen in the design and would therefore be at the expense of the resultant illumination intensity.

STEEL CONDUCTORS FOR ELECTRICAL WORK

By D. Street.

GERMANY set the fashion in the use of steel conductors for electrical light work indoors, because, as all the world knows, she requires all the copper she can get hold of for her shells, but now America is following suit because copper is dear; the war has sent up the price to figures that copper mine owners have only hoped for; and now British electrical engineers are also turning their attention in the same direction. Every one is talking of the big bill to be paid after the war and how it behooves everyone else to be saving in every possible way to help pay the bill. After the war it is more than probable that there will be a good deal of inside wiring done in buildings for electric light and power. The metallic filament incandescent lamp enables electric light undertakings to compete very favorably with gas, even in towns where gas is cheap and electricity dear, while the advent of the half watt lamp promises to enable the electric light to sweep the board. In addition, electricity is becoming more and more used in plates of business and private houses for heating and power. Electric cooking is also steadily making its way, as well as the heating of offices and rooms in private houses that are only used occasionally; the latest one price hotels in London have electric fires in all the bedrooms.

All this means more and more small insulated electrical conductors; a great deal of copper. If iron or steel can be substituted for copper for all conductors below a certain gauge, there will be a great saving in copper that can, of course, be used for other purposes; and there should be a considerable saving in cost.

Relative Efficiency

Iron and steel wire of any given gauge, the small gauges for instance used for the bulk of inside work, is only a fraction the cost of copper wire of the same gauge. Iron and steel have electrical resistance six and seven times that of copper; but in a very great number of cases, if the matter is carefully gone into, it will be found that the increased resistance is not of much consequence.

(Continued on page 300.)

Association and Personal

H. A. Harrington, of Toronto, secretary of the Retail Merchants' Association of Canada, has been appointed Assistant Ontario Fuel Controller.

Charles C. Ballantyne, head of the Sherwin-Williams Paint Co., Montreal, and a prominent business man of that city, has been appointed Minister of Public Works in the Dominion Government.

John Dennis has been appointed inspector of stationary and hoisting engineers under the supervision of the Stationary Engineers Board, Department of Public Works for the Province of Ontario. Mr. Dennis who has been serving in the R.N.C.V.R. for the past year was also a member of the C.E.F. until transferred. He served in the British Navy for nine years in the capacity of engine room artificer.

F. Borysewicz has been appointed assistant general manager for Canada, of the Liquid Air Society, with headquarters in Montreal. Before coming to Canada, Mr. Borysewicz was connected with the work of the Society of Japan, having taken a similar position there some years ago, previous to which he had been associated with the head office in Paris, France. In the absence of Mr. Jordan, who is now in France, Mr. Borysewicz is acting general manager.

Lawrence H. Cooney, general manager of the St. Algoma Steel Co. plant and wharves at Sault Ste. Marie, Ont., has resigned. He was for many years in charge of the rolling mill department of the Ohio Works, Carnegie Steel Co., Youngstown, Ohio, before coming to Canada three years ago. He is to be succeeded at the Algoma works by **James Nelson**, who for the past year has been in charge of the duplex department of the Bethlehem Steel Co. at Bethlehem, Pa.

The Electric Furnace Construction Co., Philadelphia announces that **Frank W. Brooke**, who was originally connected with the Gronwall Dixon furnace at Detroit, and latterly as metallurgist for the Ludlam Steel Works and the Ludlam Electric Furnace Co., is joining their staff as director. Mr. Brooke will be responsible for the construction and running of the Greaves-Etchells Furnaces. He will be assisted in the erection and installation by **G. W. Ketter, B.Sc.**, who has installed a great many of the electric furnaces now running and who has just completed the installation of ten furnaces for the British Forgings Co., Toronto.

A. W. McLimont, a leading traction expert, has been appointed general manager of the Winnipeg Electric Railway Co., in succession to Wilford Phillips who has retired. Mr. McLimont is a Canadian and was born in the city of Quebec. Although a young man, he has held a number of important positions, but the work which brought him most prominently in the public eye was the electrification and operation of a considerable proportion of the transportation lines of New York. Mr. McLimont was employed as engineer under the New York Public Service Commission in New York, and became so successful that his services were in demand throughout the United States. Latterly he has been in control of some nine hundred miles of road, constituting the Michigan United Railway System.

EFFECT OF STORAGE ON COAL

A REPORT on the deterioration in the heating value of coal during storage, covering a five-year period, has just been issued by the Bureau of Mines, Department of the Interior, as Bulletin 136, Horace C. Porter and F. K. Ovitz being authors.

The tests show that the amount of deterioration of coal in heating value during storage has commonly been overestimated. Except for the sub-bituminous Wyoming coal, no loss was observed in outdoor weathering greater than 1.2 per cent. in the first year, or 2.1 per cent. in two years.

The loss in heating value is given for New River and Pittsburgh coals during five years' storage in the open air and under water, for Pocahontas during two years' storage in the air, and for Sheridan, Wyoming, coal during two and three-quarters years' storage in the air.

The tests with New River and Pittsburgh coal were made to determine the advantage to be gained by storing coal under water, and particularly under salt water. The results show that storage of New River coal under water effectively prevents deterioration of calorific value and that storage in the air under severe conditions causes only small deterioration, about one per cent. in one year's exposure and about two per cent. in two years. After two years the loss is continuous but slow, reaching 2.5 to 3 per cent. in five years. The deterioration of Pittsburgh coal during one year's open-air storage was practically negligible. During the second, third, fourth and fifth years the deterioration proceeded very slowly and did not reach an amount greater than 1.1 per cent. in five years. The submerged portions suffered no loss measurable by the degree of accuracy of the methods used.

The tests of Pocahontas coal, a semi-bituminous type, were undertaken chiefly to determine the effect of tropical conditions in Panama. They were made on an outdoor pile of 100 tons of run-of-mine coal. During two years' outdoor exposure this coal deteriorated less than one per cent. in heating value.

The Sheridan, Wyoming, sub-bituminous coal, known also as "black lignite," is commonly supposed to deteriorate rapidly in storage, especially by "slacking" or crumbling of the lumps. Under the conditions of the tests this coal lost 3 to 5.5 per cent of its heat value in two and three-fourths years' storage, the greater part of this loss being in the first nine months. In general, the lumps became badly cracked, but retained their form sufficiently to permit ready access of air. However, they were weakened so that they broke up badly on handling. By the use of bins with air tight bottoms and sides and a protecting layer of fine slack on the surface, the deterioration of Sheridan coal in heat value can probably be kept below 3 per cent. in one year, and the physical deterioration can also be largely prevented in the under portions of the pile.

Detailed results and a full account of the tests and analytical data are given in the bulletin, which may be obtained free of charge by addressing the Director of the Bureau of Mines. Washington, D.C.

OPERATOR ORGANIZATIONS

British Columbia Association of Stationary Engineers, Vancouver.—Subordinate Lodges at Vancouver, Victoria, New Westminster, Cumberland, Merritt, and Fernie.

North-West Association of Stationary Engineers, Edmonton, Alta.

Manitoba Association of Stationary Engineers, Winnipeg.

Canadian Association of Stationary Engineers, Hamilton, Ont.—Subordinate Lodges at Montreal, Toronto, Hamilton, Ottawa, Brantford, Guelph, Kitchener, Chatham, Ont.; St. John, N.B.; Owen Sound, London, Stratford. Belleville, Kingston, Sudbury, St. Thomas, North Bay, Port Arthur, Sarnia, and Windsor, Ont. The executive officers of the C.A.S.E. Grand Lodge are as follows:—

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Vol. X. OCTOBER, 1917 No. 10

PRINCIPAL CONTENTS

High Pressure Air Compressor Design and Application.....277-282
General 282-284
Wood Fuel vs. Coal....Coal Production in Canada.... Engine House Efficiency....Replacing Gasoline with Coal Gas.
Power Transmission Section 285-287
Cooling of High Pressure Air Compressors....Transmission Speed Data Chart....Ball Bearings....Oiling the Line Shaft.
Steam and Its Generators 288-289
Gas Explosions in Boiler Furnaces....Motive Power for Small Users.
General 289
Development of Oxygen Manufacture....Large Chimneys.
Refrigeration 290-291
Raw Water Ice and Power for Same....Principle of Mechanical Refrigeration....Beginning of Mechanical Refrigeration.
Electricity and Hydraulics 292-294
Commutator Troubles....Steel Conductors for Electrical Work....Tungsten Lighting.
Association and Personal 295
Editorial 296
Accident Prevention....Labor After the War.
The Operators' Point of View 297-300
Does a Piston Stop at Reversal?....A Reverse Belt Drive ....Investigating Defective Magneto....Practical Observations on Lubrication....Setting Valves of Brown Engine.... Straightening Shafts....Fastening Screws and Nuts....A Handy Safety Valve Chart.
Operators' Instruction Course 301
Refrigeration Questions and Answers.
Progress in New Equipment 302-304
Recent Developments in Blast Furnace Blowing Equipment....Continuous C.O.2 Indicator....Oil Circuit-Breaker Accessories.
Selected Market Quotations (Advtg. Section) 48
Trade Gossip, Catalogues 50

ACCIDENT PREVENTION

CONSERVATION of life and energy has probably never before been so deeply impressed upon our minds as now. The need of preserving and protecting humanity from the risks of permanent or temporary disablement, arising from industrial activity, has been much emphasized by the knowledge that the past three years has shorn us of much of that man power which is so indispensable to our national development in the arts, crafts and manufactures. What may tend to increase the possibilities of accident, and likewise the responsibilities of the employer and the employed, is the advent of woman labor into the ranks of metal-working plant operators. While the likelihood of accident may be no greater in one case or the other—the female than the male, the fact that the so-called weaker sex must inevitably take a prominent part in post-war development, should be a stimulus to those concerned, to eliminate, or at least constrict the opportunities for injury that have ever been incidental to most phases of manufacture.

While safe-guarding methods and devices are deserving of just commendation they should never be wholly relied upon as an infallible proof of non-liability to injury. No proposed or adopted method of operating or guarding machine mechanisms should be termed fool-proof, even though it has been amply demonstrated that it is practically impossible to tamper with or destroy its intended purpose. The mere statement that a thing is fool-proof implies that it is proof against a fool's meddling, and any fair-minded person would or should resent the implication. It is invariably within the power of the workman to "make" or "mar" any new innovation—providing its effectiveness is being tried for the first time.

It does not pay to "force" protection on factory employees, but it does pay to have them realize the many advantages that are to be derived by adapting themselves to the changed conditions. Some men unfortunately become easily prejudiced, and will for a time do all in their power to deter rather than assist such methods as are advanced for their own welfare and protection. No safety or protective device can be entirely successful without the absolute co-operation of the employees it is intended to serve. If a safety method has any outstanding advantages —and few have not a fair proportion, it should be the duty of the workman to adapt himself as rapidly as possible to the conditions which it imposes, because eventually he will be the chief beneficiary.

LABOR AFTER THE WAR

THERE can be no doubt but that the greatest of after-war problems will be the relations between capital and labor. Men are now being paid wages for munitions and other war-time work which has raised the level of the market to previously unheard of levels. True much of the increased return has been absorbed by the higher cost of living, but in the period after the war, when munitions work stops—when the nations now spending so recklessly start to retrench—the present returns for labor cannot be expected to last. The crux of the situation will be that industrial wages will decline more rapidly than will the cost of living and the civilian individual will then feel the pinch of war conditions, which, generally speaking, he has been far from doing up to the present time.

When the demand for munitions ceases and there is still a shortage in the world food supply, Canada should take her place in the sun to a greater extent than ever as a producer of foodstuffs. For a time at least, especially with the return of the troops, the movement of population promises to be from the urban centres to the rural districts, just as it was the opposite for months after war industrial activity commenced, and not a little evidence is already forthcoming that a "back to the land" movement of fair proportions is gaining momentum and popularity.

The Operators' Point of View

DOES A PISTON STOP AT REVERSAL?

By W. F. Schaphorst, M.E.

R. W. MILLER'S query in your issue of Oct. 4, inspires me to write my convictions pertaining to this question which has been the cause of much "argufication" from time to time.

Yes, a piston stops at reversal. That is, at each end of the stroke of the piston its velocity is zero, and when the velocity of a thing is zero we generally conclude that the thing has "stopped." Mr. Miller states that to stop means to produce a "state of rest." I do not like to use the word "rest" in connection with a piston, because it often signifies sleep, repose, death, and such other items that have comparatively long duration. A piston doesn't rest, therefore, because the period of reversal is infinitesimal. I cannot state "how long" a piston stops, in answer to Mr. Miller's query, nor can anybody else. All I know is that as the piston approaches the end of its stroke, its velocity decreases gradually, and when the end of the stroke is reached, the velocity is zero. At the beginning of the return stroke, then, the velocity is zero from whence it accelerates again to a maximum.

Motion, you know, is only relative anyway. That point has been threshed out very carefully in text books on kinematics, physics, etc. I am pretty sure that all authorities agree that a piston stops at reversal. If it didn't stop, how could it ever start moving in an opposite direction, and all in the same straight line? In a flywheel the particles in the rim constantly change in velocity, but not in speed. Quoting Prof. Goodman: "The velocity of a body may be changed by altering the speed with which it is moving, or by altering the direction in which it is moving. It does not follow that if the speed of a body be uniform, the velocity will be also. The idea of velocity embodies direction of motion, that of speed does not."

We can, therefore, conclude that there is a considerable difference in definitions of words that we commonly regard as synonyms, and in that event "rest" may mean a period of anything from a second to a day, or thereabouts.

As for the argument, "If the piston stopped even for an infinitesimally small fraction of a second, would not the flyhweel to which it is connected stop also?" the piston is no more connected to the flywheel than is the base of the engine. There are several pins connecting the piston with the flywheel, whereas there is but one pin between the base and flywheel. Surely the base is at actual "rest" all of the time.

There are several other instances in which we have "stopping and moving" motion as in the automobile or wagon or carriage tire. A given point in the periphery of the tire moves with variable speed from zero to twice the velocity of the car. When the point is in contact with the road it does not move at all. It stops. Its velocity is zero. As for the duration of the stop—nobody can answer that any more accurately than can Mr. Miller's question be answered.

This takes me to a pet idea of mine pertaining to the question, "Does light stop at reversal?" That's a question that isn't so easily answered, because light, you know, travels at a velocity that is fairly uniform through the air, through a vacuum through glass through water, etc. Now, when light strikes a mirror perpendicularly and is reversed in direction, does it stop? There is no deceleration or acceleration. The writer knows of no reason why there should be a change in velocity, because light has no mass or weight, and therefore concludes that there is no changed velocity. In that case, therefore, the inference must be reached that there is no stopping for there can be no zero velocity when the thing or phenomena or whatever it is is in constant motion.

In comparison the piston problem is easy. There is no question but that the piston stops. The best way in which to oil a piston rod is to oil it at the end of its stroke—when it isn't moving. An automobile tire, you see, catches the mud in a muddy road when its velocity is zero and flings it off soon when high centrifugal force develops. The same is true when you or I run through mud. Mud clings to our shoes when they are in contact and aren't moving at all, but is often thrown off again before the same shoe again strikes or touches the ground.

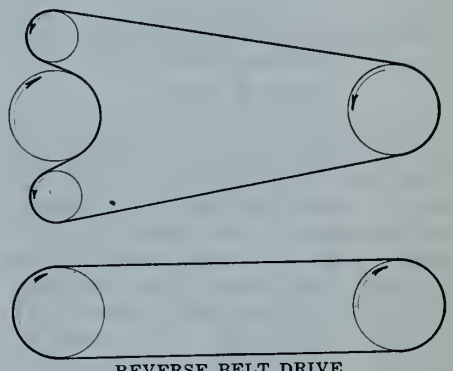
These analogies may seem crude, but in the mind of the writer they are proofs that such objects as pistons, automobile wheels, shoes, etc., all stop at one time or other at periodic intervals.

As for the last paragraph: "To controvert the theory that the flywheel stops, we find in the definition quoted that the point executing the harmonic motion must move with uniform velocity. How can the flywheel stop twice in one revolution, and yet have any point in its circumference move with uniform velocity? —the motion of the piston is just as continuous as the flywheel." This is answered by the quotation above from Prof. Goodman's splendid work, "Mechanics Applied to Engineering." The velocity of a point in a flywheel rim "in a given direction" becomes zero once each revolution. The speed of the flywheel, aside from the fluctuations due to variable load, is constant.

A REVERSE BELT DRIVE

By A. L. Loy

IN a crushed stone plant which the writer recently visited the reverse belt drive for the main crusher was obtained in the manner shown in the drawing rather than by crossing the belt as is the usual practice. Those in charge of the plant were unable to explain the advantages obtained by this design but claimed that it had given perfect satisfaction. Certainly its efficiency would not be as great as the crossed belt due to the friction loss occasioned by the two idlers and the reverse bend would be harder upon the material of the belt. Of course, it is possible to secure a



REVERSE BELT DRIVE.

greater arc on contact by the proper location of the two idlers and this may have been the deciding factor.

INVESTIGATING DEFECTIVE MAGNETO

By J. E. McCormack.

A gasoline engine was equipped with a rotary magneto and with batteries also. The idea was to start on the batteries and switch onto the magneto when speed was up, but as the engine failed to operate on the magneto (in fact the magneto

was supposed to be of no use) the batteries were used entirely for some months. One day I removed the magneto, coil spark plug and connecting wires and placed the magneto on the stand of an old sewing machine from which the head had been removed. I removed the governor pulley from the magneto and bored out an empty (sewing thread) spool to fit the arbor, then used this for a pulley and a grip strap for a belt, I ran the magneto up to approximate speed by pedaling and kept it going and kept adjusting the vibrator on the coil until I got some buzz, and then found that a half turn of the screw either way would stop the buzz. This shows the fineness of the adjustment necessary in that case. The proper point thus located was 3 or 4 turns from where it had been set for use on the batteries. With the new adjustment of the vibrator it was possible to start on the batteries and then run on the magneto, thus greatly saving the said batteries. With the magneto connected up on the engine it had been practically impossible to adjust the vibrator to it, because the engine would not hold up speed sufficiently long, but now with the vibrator set for the magneto, the batteries will work with the same adjustment and it is O.K.

No fastening was required to hold the magneto on the sewing machine stand for testing. Its weight was sufficient to hold it steady and in place. During the testing, I had the ground connection bound to the outer nut of the sparkplug, and the secondary attached to the end of the plug in the ordinary way. This completed the circuit the same as though the spark plug had been screwed into place on the engine and the ground wire attached to the engine frame in the customary manner.

PRACTICAL OBSERVATIONS ON LUBRICATION

By D. O. Barrett

IT is surprising that in the design of up-to-date heavy-duty machine tools how much time and attention have been devoted to certain features of construction and how little to other seemingly unimportant parts but which become quite prominent when trouble occurs as it generally does. One particular place where the above is applicable is in connection with the countershafts usually supplied with all machine tools. On some heavy-duty lathes, in particular, built by manufacturers whose reputation tells the story of their success, countershafts are sent out which are constructed no more rigidly than those of five or ten years ago. We still find light shafting and hangers with long spans between bearings and with light clutches which are continually slipping and will not stand up to the regular work for which the machine is designed.

One source of continual trouble is the lubrication of the loose pulleys or the main driving pulley, in case a clutch is provided. These pulleys have, in most cases, a hole drilled through the hub into which a small quantity of oil may be poured but when the pulley starts to revolve centrifugal force will cause the oil to be thrown out. This applies equally well to the average drill press, which is provided with tight and loose pulleys.

In starting operations in a shop equipped throughout with new machine tools, trouble was experienced from these loose pulleys galling on the shaft due to insufficient lubrication. After loosening up several of these only to have the same thing occur again in a short time,

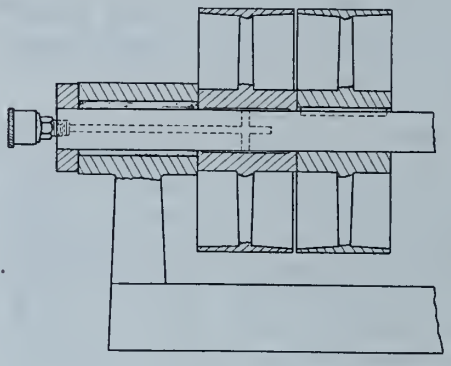


FIG. 1.

the remedy as shown in Fig. 1, was decided upon after which no further trouble was experienced. The shafts were removed and a hole deep enough to reach to the center of the loose pulley put in, with a hand feed grease cup at the end. At the center of the pulley a hole was drilled entirely through the shaft and a couple of extra deep grooves were cut in the pulley bore. The grease could thus be positively forced where most needed. Another advantage was that the oiler could tighten up the cup while the driving belt was on the loose pulley. This method gave such entire satisfaction that all new countershafts and drill presses were equipped accordingly.

Another case where the same method was used to good advantage was in a heavy-duty lathe which had been operated but a few days when the back gears galled on the eccentric shaft. This was removed and drilled out as in Fig. 1 with

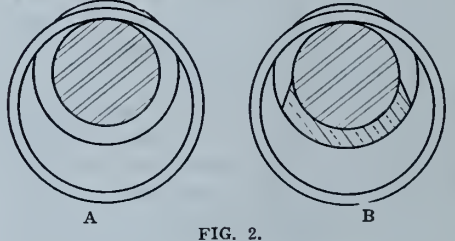


FIG. 2.

a grease cup at the end of the eccentric shaft and no further trouble was experienced.

The countershaft bearing on one of the larger boring mills was continually heating even though supplied with an excess of oil which would seem to be used effectively as the bearing was provided with a ring oiler. Upon investigation it was found that there were two separate bushings in the bearing with the oiling ring running between them as at A, Fig. 2. The oil was thus merely carried around the shaft between the bushings, very little running along the shaft and getting into the bushings. Had the bushing been made in one piece and then milled out at the top, for the ring as at B, the trouble would never have occurred as the edge of the bushing would have caught the oil, forcing it to travel along the shaft. Not having the material to make such a bushing the oiling ring was removed and the space filled with grease and a hand feed cup supplied. Little occurrences like these, while small matters in themselves, nevertheless cause great inconvenience and serve to ruin a reputation which might have been built up on the quality of the machine in general.

In connection with stationary gas engine work, the usual method of lubricating the cam rollers is shown at A, Fig. 3. These rollers are of either tool steel or machine steel case-hardened, and are made rather a loose fit on the hardened steel pin. They are generally made a fairly close fit in the slot which is milled in the end of the push rod which is of square cold drawn steel. A hole is drilled radially through the hole for oil but if the hole should happen to be in any other position than vertical and the roller is against the cam, the average operator does not take the trouble to turn the roller but contents him-

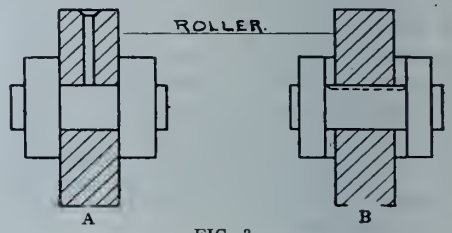


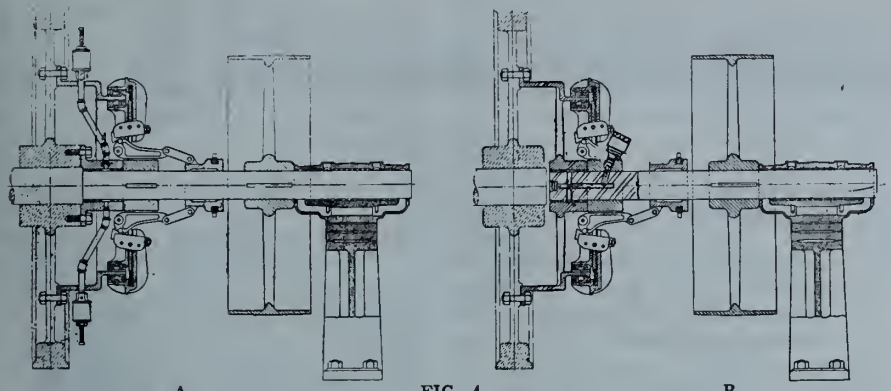
FIG. 3.

self with pouring a little oil on the side. Should the hole be filled with oil, as soon as the engine is started the centrifugal force will immediately throw it out so that in any case, the method is a failure.

A much better plan is shown at B where the slot is somewhat wider than the roller and the pin is provided with an oil groove for the full width of the slot. Oil applied at either side of the roller will at least fill the groove and cover that part of the pin which is exposed and as soon as the engine is started the roller will travel from side to side spreading the oil effectively over the pin. Oil may, of course, be equally as well applied while the roller is turning.

The usual method of lubrication for clutches and cut-off couplings attached to gas oil engines is shown at A, Fig. 4. The friction ring is bolted directly to the flywheel and the bearing for the shaft carrying the driving pulley is bolted to the wheel or cast integral with the ring. The gripping mechanism is keyed to the extended shaft. In this way the shoes remain stationary and adjustments may be made on the friction

surfaces by merely throwing out the clutch. Self-feeding grease cups are attached to the ring with pipes leading to the bearing. The cups can, of course, be filled only when the engine is shut down and no attention whatever can be given them after the engine is in operation no matter how many times the clutch may be thrown out, with the extended shaft stationary. Again, this style of cup is not very reliable in its operation since the spring operated piston in the cup may not be able to force the lubricant through the long pipe, especially in cold weather.



A FIG. 4. B

At B is shown a method which has proved far more satisfactory and costs little, if any more, to install. The shaft is drilled from the end and then plugged, the hole being deep enough to reach back to the member carrying the shoes. A hole is drilled through the shaft at the center of the bearing and another hole is drilled into the shaft to meet the center hole and corresponding to the grease cup which is carried in the hub of the mechanism. By throwing out the clutch and allowing the engine to run, the cup may be screwed down at any time thus insuring an ample supply of lubricant. Of course, it is necessary that the part carrying the grease cup maintain its exact position with relation to the shaft and this may be accomplished by drilling a shallow hole in the shaft for a set screw which is usually provided in the casting. Hand feed cups are the best for this arrangement as the grease may be positively forced where needed.

SETTING VALVES OF BROWN ENGINE

IN reply to inquiry by R. R. Lambert regarding rules for setting valves of a Brown engine, the following instructions are submitted:—

Steam Spindles

Before setting the valves to time with the crank see that the steam spindles are so adjusted that the valves have the proper lap and the steels on the latch and the lifter have the proper clearance. When the dashpot pistons are resting on the bottoms of the pots and the lifter is at the bottom of its stroke, there should be 1/16 in. clearance between the steels on the latch and the lifter and the lap of the valve should be 3/16 in.

Governor

Next look at the governor. The travel of the governor is usually 5/16 in., but should not exceed ⅜ in. When the governor balls are at their lowest position, the steam valves should trip. When the valve is opened full port and when in their highest position, the valves should trip just when the port is opening. Having adjusted the spindles and governor, the next thing is to set the valves to time with the crank. For the steam valves put the engine on the dead centre and give the valves about 1/16 in. lead. For the exhaust valves set to close at 1/10 of the stroke from the end, being careful to take into consideration the hand to which the engine is running, i.e., be sure that the exhaust valve is set to close at 1/10 of the stroke from the end to which the piston is moving.

STRAIGHTENING SHAFTS

THE straightening of shafts in the lathe is, like many another job, when one knows how to do it, quite a simple one. A knowledge of what is required, and a fair modicum of patience are desiderata and indispensable. Given a shaft, say 2½ in. in diameter, straight from the drawing mills, such a shaft being all that may be desired as regards size and soundness, but with a slight bend, and perhaps two, in its length, such bends precluding its use as a shaft, and fit to run in ordinary journals or in ball bearings. The first thing to do is to chuck one end, run the other in the steady and centre that end with a large centre drill. Then the other end, previously held in the chuck is held in the steady rest and faced and centred. The shaft is then provided with a pair of suitable half clips—it must not be gripped in the chuck—or a suitable driver and the lathe started. Bends in the shaft may be easily discerned, and a rough judgment made as to the size of the "job."

Preliminary Inspection

Notice having been taken as to the extent of the bends, it is as well then to let the centre of the shaft run freely in a steady. The acquisition and use of the steady at this stage, and in the centre of the length of the shaft is simply for the purpose of eliminating an accession of spring which would accrue, as a result of out of balance, were the lathe to be run at a considerable speed. It is quite possible, however, that the worst of the bend may be situated just about in the middle of the shaft. If such be the case, another and more suitable position must be found, i.e., if there be one. If there is no part of the shaft found to run, even approximately true, or in other words, sufficiently true to run in the steady, then it is a case of running the lathe slowly round, so that there is no "swing" as the shaft is rotated, and to choose a part to set true first. When such is done, the steady should be applied and attention given to the straightening of the parts on each side of the steady. It should be observed, however, that there is no royal road to the art of straightening shafts any more than there is to the art of flattening a circular saw, or a large steel plate. An expert at either is able to do with a few blows more than a novice can do in an hour, if at all.

Theory of Drawing

As with circular saw or steel plate flattening a "drawing" of the shorter parts is the essential, and the man who knows how to do this well may become an expert on the straightening of shafts. But we may hear the novice exclaim when his patience has been exhausted towards the removal of recalcitrant bends, "when I get this bend out another comes in." Just so, and this will be the case generally, until by judicious drawing the bends become reduced in extent, and the shaft becomes approximately, or, as it is sometimes called, commercially straight. It may be said that the method of drawing—with the aid of copper pad—flogging hammer and steel lever,—the old-fashioned way—is far more preferable, and a more direct remedy for bent shafts than any crowbar; and for this reason: If the shaft has become bent in transit, or by any other means, the convex side had become long by stretching—and common sense will support the idea that to bring the shaft back to an approximate normal, the concave side should be equally stretched. That may be accomplished with the orthodox accessories, copper pad, flogging hammer and steel bar—as a lever—and by no means excluding a good heavy laborer for the bar, a useful man for the hammer and a skilful man to hold the copper pad and direct operations. Such a man, where many shafts are required to be dealt with, is worth high pay, though difficult to discover.

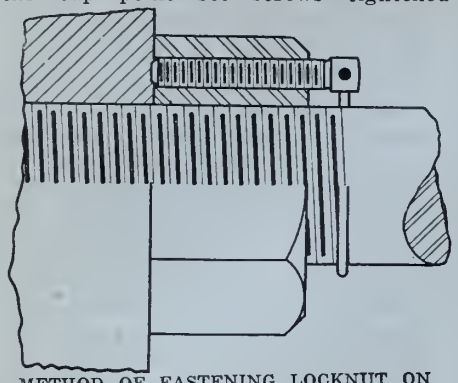
FASTENING SCREWS AND NUTS

By A. L. Loy.

CONSIDERABLE trouble had been experienced with the nuts on the piston rods of gas engines working loose. These nuts were used as lock nuts on the rod where it entered the crosshead. Tightening up the nut draws the threads on the rod to the back of those in the head, so that the pressure of the explosions comes directly on the nut. Should the nut become loosened only slightly, the small movement of the rod in the head will soon work the nut back, and either cause the piston to unscrew or, as sometimes happens, the piston rod is forced through

the crosshead, tearing out the threads.

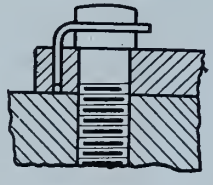
The nuts were drilled and tapped and the cup point set screws tightened



METHOD OF FASTENING LOCKNUT ON BACK OF CROSSHEAD.

against the crosshead after the main nut was tightly drawn up. Holes were drilled through the head of the cap screw and a wire was run through and then wrapped around the rod and the ends fastened together. Since the screw would cut into the metal of the crosshead a certain amount, it would have to back out this amount before the main nut could move and the wire very effectively insured that these parts would remain tight.

A wire may also be used very satisfactorily in the locking of cap screws, as shown in the cut. Holes are drilled through the heads of the screws, and also down into the piece being held by the screw, as close to the screw as convenient. The wire is pushed down into the hole and then pulled through the



LOCKING CAP SCREW WITH WIRE.

head of the screw and cut off. It is immaterial whether the holes line up, as the wire will simply be bent to correspond and cannot come out unless deliberately removed.

A HANDY SAFETY VALVE CHART

By N. G. Near

A FORMULA which I believe is worthy of working into chart form is presented herewith. This is the formula:

$$A = \frac{0.2074\ W\ G}{P}$$

Where A=the area of the safety valve in square inches;

P=the absolute pressure in pounds per square inch;

W=pounds of water evaporated per square foot of grate surface per hour;

G=the grate area in square feet.

To use the chart simply lay a straight edge across the chart twice as shown by means of the dotted lines drawn across this chart and the area is immediately found in column C without doing any pencil or mental figuring at all.

First connect the evaporation per sq. ft. of grate surface per hour (column A) with the grate area (column D) and locate the intersection with column B. Then run a line through the absolute pressure (also in column A) and the intersection which has already been located and the intersection of this line with column C gives the area.

For example, what area of safety valve is required where 60 pounds of steam are evaporated per square foot of grate per hour, where the grate area is 40 square feet, and where the steam pressure is 150 pounds absolute?

The dotted lines show how this particular problem is solved. Connect the 60 (column A) with the 40 (column D) and locate the point where the line cuts column B. Then run a line through this point and the 150 (column A) and an extension of this line cuts column C at the point 3.3. The area of the safety valve should therefore be at least 3.3 square inches.

I believe this method of making double use of column A will interest readers. It serves both for the pressure and the evaporation. The first line connecting the 60 and 40 represents a multiplication as is evident by inspection of the formula. The second line performs the division.

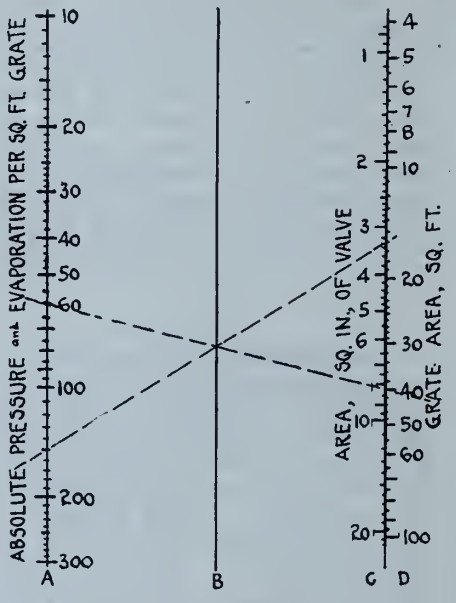


CHART FOR ASCERTAINING SAFETY VALVE RATIOS.

STEEL CONDUCTORS FOR ELECTRICAL WORK

(Continued from page 294.)

The smaller currents required for the metallic filament and half watt lamps allow of distributing conductors of very much higher resistance being employed with the same result at the lamps.

According to the rules issued by the Institution of Electrical Engineers, a total drop of three volts only is allowed, practically inside a building; but a drop of three volts with a certain number of the old carbon filament lamps, taking anywhere up to four watts per candle, is a very different matter from a similar drop with either the metallic filament lamp or the half watt lamp. Merely substituting half watt lamps for carbon filament lamps, where this is practicable, should enable the resistance of the distributing conductor to be increased by at least the difference between the resistance of copper and steel. And this is not all; by the rules of the Institution of Electrical Engineers, no copper conductor is allowed to be employed for work of the kind mentioned of a smaller gauge than No. 18 S.W.G. The reason for this is a purely mechanical one. The passage of an electric current through any conductor tends to make it brittle, particularly at the points where connections are made to terminal screws and at joints; with the result that if the wires employed are allowed to be too small there is a strong tendency for them to be continually breaking at those joints. When joints are made also, as is well known, it is difficult to leave the metal conductor on each side of the joint in the same condition as before the joint was made; there is an increasing tendency to brittleness. Soft steel wire, such as could easily be drawn, would have a very much higher tensile strength than coper wire of the same gauge; and if properly drawn and properly handled should be very much stronger in every way; in fact, so far as mechanical strength is concerned, it should be quite safe to employ soft steel wire of No. 20, and even smaller gauges. The soft steel wire should stand the handling of careless wiremen very much better than copper wire.

Manufacturers of insulated wires would have to tackle the problem of insulating the iron wires very carefully, but there is no reason to suppose that there would be any difficulty about the matter.

Possible Hysteresis Loss

One objection to the use of iron or steel wire is the possible loss that may arise from hysteresis in the wires themselves. It will be remembered that when a current of electricity passes through a conductor it creates a mannetic field around the conductor; and every magnetisable substance meeting the lines of force thrown out from the conductor, responds to them. As the great bulk of electric lighting is now done by the aid of alternating currents, this means that each of the wires forming a pair of conductors, if they were of iron or steel, would be magnetized alternately fifty times a second, or whatever their periodicity might be; and there would be a certain consumption of energy in accomplishing this.

For the small conductors employed for indoor work the loss due to this would be very small; it would be merely an addition to the loss due to the power factor of the whole system, and not a great addition. It is found of advantage to employ alternating currents for distribution. for light, heat and power, notwithstanding the undoubted losses due to the power factor, even under the most favorable conditions, and the small aditional charge due to the employment of iron or steel wires for indoor work would be really inappreciable.

Operators' Instruction Course

REFRIGERATION QUESTIONS AND ANSWERS

Question.—On what principle does a refrigerating machine operate?

Answer.—You compress by means of external force a gas or vapor and extract its heat to diminish its volume. By causing the compressed gas or vapor to expand you lower its temperature. Heat is again absorbed by the gas or vapor, and the latter resumes its original condition, constituting the refrigerating effect of the arrangement.

* * *

Question.—On what does the efficiency of a refrigerating machine depend

Answer.—The efficiency depends on the difference between extremes of temperature.

* * *

Question.—On what does the useful effect of a refrigerating machine depend?

Answer.—It depends upon the ratio between the heat units eliminated and the work expended in compressing and expanding. This result is independent of the nature of the body employed.

* * *

Question.—What would be the amount of heat absorbed per hour by a nest of 1-inch pipe 24 feet long and consisting of 32 pipes? The temperature difference between the brine in the pipe and the freezing room is 20 degs. F., and there are 30 4-inch open return bends.

Answer.—A return bend with openings at 4-inch centres has approximate surface area of 50 sq. inches. Area of 30 bends $= \frac{50 \times 30}{144} = 10.4$ sq. ft. Actual length of pipes = 23 ft. 4 in. Circumference of 1 pipe $= 1.3 \times 3.1416 = 4.084$ inches.

Surface area of pipes $= \frac{280}{12} \times \frac{4.084}{12} \times 32 = 254.115$ sq. ft.

Total surface = 254.115+10.4=264.515 sq. feet.

The coefficient of radiation or absorption for clean iron pipe is .566, which means that .566 B.t.u. of heat will be absorbed for every square foot of surface per hour per degree F. difference in temperature.

The amount of heat absorbed is, therefore, $264.515 \times 20 \times .566 = 2994.31$ B.t.u.

Question.—How many British thermal units would be required to melt one ton of ice at 10 deg. F.?

Answer.—The latent heat of fusion for ice is 144 B.t.u. per pound but, in refrigeration calculations, 142.2 is generally used. The specific heat of ice is 0.504. The heat required to raise 1 ton of ice from 10 degrees to 32 degrees (the melting point) is $(32-10) \times .504 \times 2000$ or $22 \times 2000 \times .504 = 22{,}176$ B.t.u.

The heat required to melt 2,000 pounds of ice at 32 deg. would be $2000 \times 142.2 = 284{,}400$ B.t.u. Total heat required then is $22{,}176 + 284{,}400 = 306{,}576$ B.t.u.

or the equivalent of about $\frac{306{,}576}{10{,}000} = 30.65$ pounds of coal burned under a good boiler.

* * *

Question.—How can the "cooling effect" produced by a refrigeration machine be calculated?

Answer.—There are two general methods of accomplishing this: (1) By its effect on brine or other medium. The quantity of brine, its specific heat, the temperatures through which it is cooled and the time required all determined by observation. From these the number of tons of ice that could be melted per 24 hours can be calculated.

(2) By the amount of ammonia evaporated and passed through the system, the back pressures and compression pressures being known. The cooling effect of the evaporation of the ammonia under these conditions can be calculated and converted to tons per day.

* * *

Question.—The total output of a refrigerating plant is taken up by calcium chloride brine which is circulated by an 8×10 double acting brine pump making 104 strokes per minute. The temperature of the brine leaving the tank is 10 deg. F., and that of the returning brine is 36 deg. F. What is the amount of refrigeration produced by the plant?

Answer.—Specific heat of brine at 13 deg. Baume, that is, containing 15 lbs. Ca Cl. per cubic foot is 0.884. The quantity of brine passed by the pump per day is equal to the stroke volume of the pump multiplied by the number of strokes and by the number of minutes in a day. This is equal to $8 \times 8 \times .7854 \times 10 \times 60 \times 24 = 723{,}830.4$ cubic inches.

Specific gravity of brine = 1.103 and .036 pound.

Weight of brine is therefore $723830.4 \times .036 \times 1.103 = 28{,}742.016$ pounds.

The temperature through which the brine is raised is 36—10 = 26 degrees. The total number of thermal units absorbed by the brine is number of pounds $\times$ specific heat $\times$ range of temperature $= 28742.016 \times .884 \times 26$. Tons of refrigeration is

$$\frac{28742.016 \times .884 \times 26}{288{,}000} = 2.293 \text{ tons.}$$

* * *

Question.—What would be the capacity of a plant with a compressor 16×32 operating at 50 r.p.m. under 185 pounds head and 15.67 pounds back pressure?

Answer.—Area of compressor piston is $16 \times 16 \times .7854 = 201.06$ sq. inches.

Compressor displacement = area of piston $\times$ stroke $\times$ strokes per minute $= 201.06 \times 32 \times 50 \times 2 = 643{,}392$ cubic inches $= \frac{643{,}392}{1728} = 372.3$ cubic feet per minute.

With a displacing efficiency of 90 per cent., this becomes $372.3 \times .90 = 335.07$ cubic feet. Specific volume of ammonia at 15.67 pounds pressure is 9.3 or 9.3 cubic feet of vapor = 1 pound. The number of pounds of ammonia evaporated is, therefore $\frac{335.07}{9.3} = 36.03$ lbs.

Latent heat of ammonia at back pressure of 15.67 pounds is 566.

As the temperature of ammonia entering the expansion coil must be lowered to that of the expanding vapor, the cooling effect necessary to do this, or in other words, the heat of the liquid, must be subtracted from the gross cooling effect of the vaporization. The heat of the liquid at 185 pounds is + 71 B.t.u., and the heat of the liquid at 15.67 pounds is — 35 B.t.u. The difference is 106 B.t.u.

The net cooling effect of the expansion of one pound of ammonia is therefore 566 — 106 = 460 B.t.u. The amount of ammonia evaporated per minute is 36.03 pounds. Cooling effect per minute is therefore $460 \times 36.03 = 16573.8$ B.t.u. One ton of refrigeration effect is equivalent to 200 B.t.u. per minute. The capacity of the machine is then $\frac{16573.8}{200}$ = 82.869 tons.

Progress in New Equipment

RECENT DEVELOPMENTS IN BLAST FURNACE BLOWING EQUIPMENT

AFTER the general adoption of the steam turbine in large central power, the erroneous impression gained ground that the replacing of the reciprocating blowing engine by the turbo blower could only be a question of a comparatively short time. This expectation of the uninitiated was not realized and it is doubtful if it will ever be realized.

The same laws of nature which give the steam turbine advantages over the steam engine, are obstacles in the case of the turbo blower. Firstly, the steam turbine excels the steam engine only in the region below atmosphere, and in the compression of air for blast furnace use this region is absent, because, naturally the compression must start with atmospheric pressure. Secondly, the losses in the earlier or high pressure stages of the steam turbine are converted into heat which can be utilized in the latter stages, while in the turbo blower the losses in the early or low pressure stages mean additional work to be done in the latter stages. Thirdly, the steam turbine utilizes the highly efficient process of converting pressure into velocity, whereas, the turbo blower tries to utilize the very inefficient process of converting velocity into pressure. Fourthly, the central power station utilizing large turbo generators, makes power for the sake of selling it. High steam pressure, superheat and vacua which are impracticable around a blast furnace, can be introduced in the central station. Larger and larger units can also be installed, whereas the size of the turbo blower is limited by the size of the blast furnace.

While for these very reasons engineers with knowledge of the underlying principles always had their doubts concerning general adoption of the turbo blower, another rather unexpected reason has considerably delayed and hindered its introduction. The reason in question is, incorrect governing of the blower and consequent dusting of the furnace. The turbo blower is a machine supposedly free from pulsations, and great advantages were expected from a steady stream of air going to the furnace. But practice has shown that, quite on the contrary, the vast majority of turbo blowers vary in volume delivery a much greater amount than reciprocating blowing engines do. The amount of ore lost by dusting due to this fluctuation of air supply is so great that most blast furnace managers are, at the present time, afraid to install turbo blowers.

In blowing engines the course of development likewise has been following rather unexpected lines. By comparison of the number of new furnaces built with the number of new blowing engines and new turbo blowers installed, it is found that a comparatively small amount of new blowing equipment has been added. This surprising result is explained by the fact that a very large number of existing blowing engines have been rebuilt in such a way as to have a larger capacity and to serve a greater number of furnaces than heretofore. The possibility of increasing the capacity of existing blowing engines is largely due to the increase in piston speeds made possible by the introduction of plate valves which have been mentioned before in our columns. A great amount of rebuilding of existing blowing engines has been done by the Mesta Machine Company of Pittsburgh, Pa., with plate valves manufactured under Iversen patents.

The so-called rebuilding of blowing engines is, in some cases, limited to the simple replacing of the existing valves by automatic plate valves. In other instances it means more than that, namely, the removing of old cylinder heads and replacing them by heads containing plate valves. In the most extreme cases it means the removal of the whole air end including the air cylinder.

FIG. 1. PLATE VALVES ARRANGED IN CAGES TO REPLACE LARGE POPPET VALVES PREVIOUSLY EMPLOYED.

An illustration of the methods employed in replacing an old type of valves by plate valves is shown on Fig. No. 1. Here are seen plate valves arranged in cages, which take the place of large poppet valves, originally operating in the head. The cages are dished in order to reduce clearance to a very small amount. In many cases the clearance volume is smaller than it was with the original valves, while in other cases it is increased slightly, depending upon the type of valves being replaced by the cages. But even in this latter case, the advantages gained by the instantaneous opening of the valves, and the larger area secured, are so overwhelming, that the slight

FIG. 2. SHOWING HOW VALVES HAVE BEEN MADE TO FIT A PREVIOUS SEGMENTAL ARRANGEMENT.

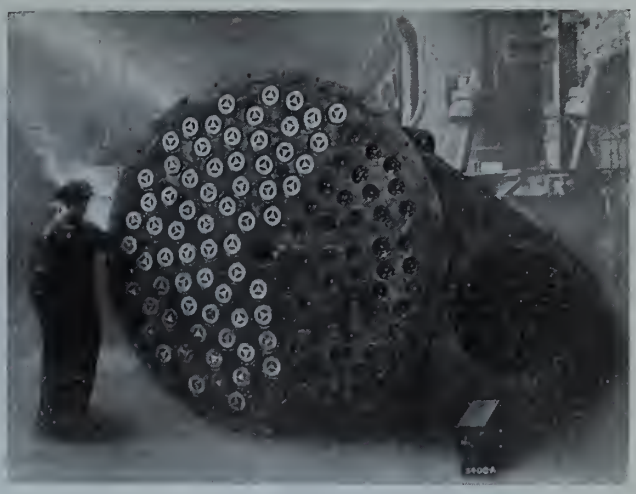


FIG. 3. ILLUSTRATING METHOD OF INSTALLING PLATE VALVES IN PLACE OF EXISTING VALVES IN THE HEAD.

increase in clearance volume fades into insignificance.

The arrangement of the valves in cages offers several advantages. The removal of one cover plate exposes all outlet valves of the cage to inspection on the delivery side. The inlet cages are made in two parts so that the removal of one cover and the top of a cage exposes all the valves of that cage to inspection. In the extremely rare case of breakage of a valve, the whole cake can be easily removed and replaced by a spare one.

Fig. No. 2 shows how valves have been made to fit a segmental arrangement of old valves. Fig. No. 3 illustrates the method of installing valves in place of existing valves in the head. This latter method as a rule gives some increase in valve area, but not enough to warrant increasing the speed of the engine materially. This method is to be recommended particularly in the case of old blowing engines equipped with leather valves. The advantage is twofold: first, the plate valves are always tight and in consequence deliver more air, whereas leather valves soon begin to leak, due to warping or charring of the leather; second, higher pressure can be blown.

The second method, namely, that of replacing old air heads with new ones, ist very widely practised at the present time. Fig. No. 4 shows the appearance of such air heads. The third and last method, namely, that of replacing the old air end has been necessary only very occasionally. Fig. No. 5 shows the appearance of such an air end.

Mention has already been made of the fact that plate valves allow higher piston speeds. This feature is beneficial in several ways. Right now, due to the poor trade of coke available, many furnaces are troubled by the necessity of more air than was used in the past when better coke was on hand. Increasing the supply of air has pulled several furnaces out of a bad predicament. More air means not only more pig iron, but in addition, more furnace gas, more steam and steady profitable operation.

The installation of plate valves, and the resulting possible increase in speed of the blowing engines, has enabled a number of plants to erect another furnace without installing additional blowing units. The heretofore customary practice of blowing a furnace with three or sometimes four tubs, has given way to the present possibility of blowing a furnace with two tubs only; and, in fact, a great many furnaces in this country are being blown to-day, using only two 84 in. diameter blowing tubs equipped with automatic plate valves. From this it can be seen that the blowing capacity of existing plants can be increased 50 to 100 per cent. by equipping the present engines with automatic plate valves.

CONTINUOUS CO_2 INDICATOR

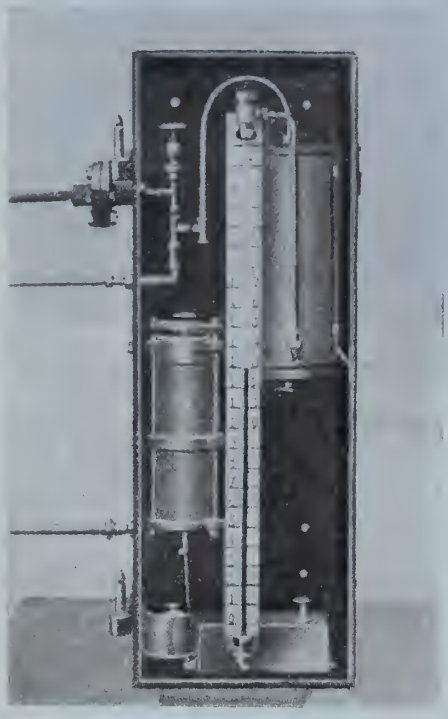
A NOVEL type of combustion analysis apparatus is illustrated in the accompanying engravings, the principal features being the absence of solutions and moving parts along with simplicity of construction and facility of operation. Referring to the diagram, it will be seen that, after passing through a filter, the flue gas enters a gas chamber in which is mounted a porous pot containing a cartridge of absorbing chemical. The inside space of the gas chamber is connected to the well of a fluid indicator having a graduated scale tube, the upper end of which connects with the space inside of the porous pot.

Passage of the gases through the apparatus is induced by a small steam aspirator, which operates continuously, and as the gases pass over the porous pot at

FIG. 4. REPLACING OLD AIR HEADS WITH NEW ONES.

FIG. 5. NEW AIR ENDS WHICH HAVE REPLACED OLD ONES.

a uniform rate, a constant amount passes into the interior and comes in contact with the absorbent which removes the carbonic acid gas, and thus causes a drop in the gas pressure surrounding the



CONTINUOUS COMBUSTION INDICATOR WITH VACUUM CONTROLLED COLUMN OF LIQUID AND GRADUATED SCALE.

cartridge. This drop in pressure causes the colored liquid in the well to rise in the graduated tube in corresponding degree, the liquid being maintained at the same height as long as the proportion of CO_2 in the flue gas remains constant.

The instrument is read as easily as an

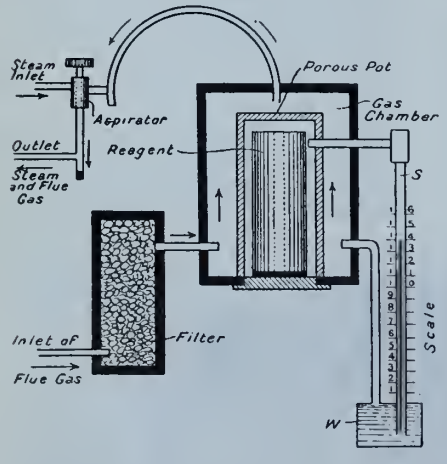


DIAGRAM ILLUSTRATING ACTION OF COMBUSTION INDICATOR.

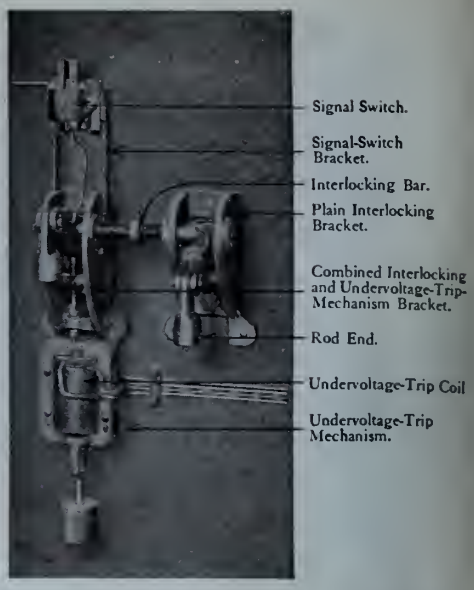
ordinary thermometer, and requires no further attention than the renewal of the absorbing chemical, which is done every few days at a weekly cost of about 25 cents. The apparatus is made by Holdsworth & Sons, Ltd., Bradford, Eng., and has an accuracy within one-half of 1 per cent. of the well-known Orsat apparatus.

OIL CIRCUIT-BREAKER ACCESSORIES

BULLETIN (DS272) recently issued by the Westinghouse Electric & Manufacturing Co., under the title of "Oil Circuit-Breaker Accessories" contains information regarding every combination of tripping and signalling likely to be required. Trip-magnet frames and coils are listed for obtaining underload, undervoltage, overload, over-voltage, series and shunt trip; several and, in some cases, all of these can be applied on the same breaker to act with the standard automatic overload trip mechanism.

For controlling the operating circuit of electrically operated breakers, central switches are listed. These can be connected with signal lamps to indicate the position of the breaker; one style has signal lamps mounted on its cover-plate. And to control the signal lamp circuits, "signal and shunt-trip cutout switches" are shown. These can be so connected as to light the proper lamps to indicate the position of the breaker at all times; they are also used to open the shunt-trip circuit when the breaker opens.

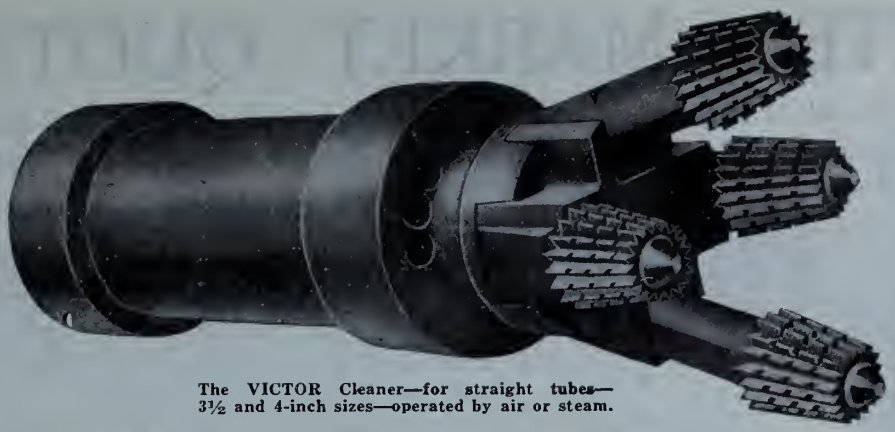
With a double-throw breaker, or with two single-throw breakers connected as a double-throw breaker, it is often desirable to have the throws so connected that with one throw closed it is impossible to close the other, and vice versa. This can be accomplished on electrically-operated breakers by interconnecting the operating circuit through a "signal and shunt-trip cutout" switch; with manually operated breakers, it is accomplished by an interlocking bar with a suitable bracket.



REAR OF SINGLE-HAND COVERPLATES OF TWO INTERLOCKED BREAKERS.

And there are described and listed: signal switches, inverse-time element attachments; bell-alarm signal-contact attachments; bell-crank accelerating devices; universal mounting brackets for mounting breakers, instrument transformers, and other accessories on the rear of the panel or on a separate pipe or angle-iron frame.

WALL MOUNTING BRACKET SUPPORTING TYPE F-1. PANEL MOUNTING BREAKER, WITH REMOTE CONTROL COMPLETE.



The VICTOR Cleaner—for straight tubes—
3½ and 4-inch sizes—operated by air or steam.

The Victor Cleans Up Again

(Both literally and figuratively)

It is a common occurrence for us to hear of a "Victor" Tube Cleaner that is making some record in the plant where it is being used—a record amount of scale that has been removed, a length of time the Cleaner is used without any repairs, or a record for speed (number of tubes cleaned) as compared with some other cleaner.

Of the many reports of this kind that are received, the following from the Chief Engineer of a large Railway and Electric Company is particularly interesting, because of the great amount of time saved by using a "Victor" Cleaner.

This Chief Engineer wrote us under date of May 5th as follows:

"We received the 3¼ in. Air Tube Cleaner during the last few days in March. It was placed in real service about April first. We take pleasure in informing you that we have subjected the machine to the most rigid tests and find it satisfactory in every detail.

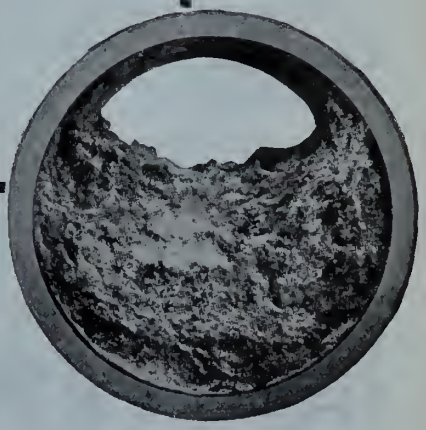
"We find in using the Water machines in a badly scaled tube that the water could not find outlet. This caused a slowing down of the machine, making it very ineffectual. As a sample of this, we had a Water machine working in a boiler when the Liberty Air machine arrived, and it took eight hours to bore one tube with the Water machine. We placed the Air machine in the next tube which was in the same condition, and it was thoroughly cleaned by the Air machine in ten minutes.

"It is rather hard, on account of our operating conditions, to give an exact estimate of the time saved with the new machine, but think I am quite conservative in saying we can thoroughly turbine a boiler in one-fourth the time it took with the old equipment."

For operation with air or steam, the "Victor" stands without an equal for speed and endurance, and these are the things that count. The "Victor" is described in Catalogue "H."

If you want to win, get a thoroughbred — that's the "Victor." It's built for endurance and speed.

Liberty Manufacturing Company
6904 Susquehanna St., Pittsburgh, Pa.



Yes, this tube is badly scaled, but its condition is no worse than some of the tubes that were cleaned in the plant mentioned above.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$36 00	$.....
1¼ in.	40 00	.....
1½ in.	43 00	36 00
1¾ in.	43 00	36 00
2 in.	50 00	36 00
2¼ in.	53 00	38 00
2½ in.	55 00	42 00
3 in.	64 00	50 00
3¼ in.	.....	58 00
3½ in.	77 00	60 00
4 in.	90 00	75 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$13 00	$13 00
Heads	13 30	13 30
Tank plates, 3-16 in.	13 65	13 25

WROUGHT PIPE

Effective July 5, 1917

Size	Black Standard Buttweld	Galvanized Standard Buttweld
	Per 100 feet	
⅛ in.	$ 5 00	$ 6 50
¼ and ⅜ in.	5 12	7 16
½ in.	6 46	8 03
¾ in.	8 17	10 29
1 in.	12 07	15 22
1¼ in.	16 33	20 59
1½ in.	19 53	24 61
2 in.	26 27	33 12
2½ in.	42 12	52 94
3 in.	55 08	69 23
3½ in.	69 92	86 94
4 in.	82 84	103 00
	Standard Lapweld	
2 in.	29 23	35 71
2½ in.	43 88	54 11
3 in.	57 38	70 76
3½ in.	71 76	89 70
4 in.	85 02	106 28
4½ in.	96 52	121 29
5 in.	112 50	141 34
6 in.	145 90	183 36
7 in.	190 40	238 00
8L in.	200 00	250 00
8 in.	230 40	288 00
9 in.	276 00	345 00
10L in.	256 00	320 00
10 in.	329 60	412 00

Prices—Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES

4" and under, 45%.
4½" and larger, 40%.
4" and under, running thread, 25%.
Standard couplings, 4" and under, 35%.
4½" and larger, 15%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 7½%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 40; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%
At warehouse ..... list plus 50%
Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$5 25
Steel bars, base, Toronto	5 50
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	5 25
Steel bars, base, Montreal	5 50
Reinforcing bars, base	5 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28	$11 00	$11 00
Sheets, Black, No. 10	12 00	12 00
Canada plates, dull, 52 sheets	12 00	12 00
Canada plates, all bright	12 50	12 50
Apollo brand, 10¾ oz. galvanized	12 25	12 09
Queen's Head, 28 B.W.G.	11 75	10 75
Fleur-de-Lis, 28 B.W.G.	11 75	10 75
Gorbal's Best, No. 28.	12 00	10 25
Colborne Crown, No. 28	11 25	10 00
Premier, No. 28 U.S.	13 75	12 70
Premier, 10¾ oz.	13 85	13 00

PROOF COIL CHAIN

B

¼ in.	$12 00
5-16 in.	11 50
⅜ in.	11 15
7-16 in.	10 90
½ in.	10 70
9-16 in.	10 70
⅝ in.	10 50
¾ in.	10 40
⅞ in.	10 25
1 in.	10 10
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	40
Delta Files	37½
Nicholson	40
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	40
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal.	26½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 50
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	11

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	$13 05
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers ..... list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass ..... add	20
Machine screws, o. and fil. hd., brass ..... add	25
Nuts, square blank ..... add	$1 50
Nuts, square, tapped ..... add	1 75
Nuts, hex. blank ..... add	1 75
Nuts, hex. tapped ..... add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	17½
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	$0 36
Solder, guaranteed	38½
Babbitt metals	18 to 70
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	4 35
White lead, pure, cwt.	18 00
Red dry lead, 100-lb kegs, per cwt.	15 45
Glue, English	0 38
Gasoline, per gal., bulk	0 31½
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	0 78
Linseed oil, raw, single bbls.	1 42
Linseed oil, boiled, single bbls.	1 45
Lead wool, per lb.	0 15
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A. ..... list plus	20
Emery Cloth ..... list plus	33 1-3
Borax, crystal	15
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granular.	0 15
Wood alcohol, per gallon	2 15
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$55 00	$53 00
Plain sheets, 14 oz., 14x28 in., 14x60 in.	55 00	53 50
Copper sheet, tinned, 14x60, 14 oz.	60 00	54 25
Copper sheet, planished, 14x60 base	64 00	60 00
Braziers', in sheets, 6x4 base	55 00	52 00
Tubing, seamless	58 00	58 00

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 55
Brass sheets 8" wide, 20 oz.	0 60
Brass tubing, seamless	0 57
Tubing, I.P.S., 1" base	0 54

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White	Cents per lb
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16
COLORED	
Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets ..... list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus 30,	10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add 40,	10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$31 00	$32 00
Electro copper	31 00	32 00
Castings, copper	30 00	31 00
Tin	63 00	63 00
Spelter	10 50	10 50
Lead	11 00	10 75
Antimony	18 00	19 00
Aluminum	65 00	62 00

Prices per 100 lbs...

ROPES AND PACKING

Packing, square braided	0 34
Packing, No. 1 Italian	0 40
Packing, No. 2 Italian	0 32
Pure Manila rope	0 39
Transmission rope, Manila	0 45
Drilling cables, Manila	0 41

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$18 00	$18 00
Sheets, 3½ lbs. sq. ft.	18 00	18 00
Sheets, 4 to 6 lbs., sq. ft.	17 50	17 50

Cut sheets, ½c per lb. extra.
Cuts sheets to size, 1c per lb. extra.

TEN YEARS AGO AND TODAY

Old style Rotor permanently abandoned seven years ago.

Ten years ago—before we brought our Turbine to its present high degree of perfection—the manufacturing difficulties made it impossible to produce a solid rotor without semi-circular slots. These slots are acknowledged as highly undesirable and built-up rotors are never made with them. We finally invented and patented a process of manufacture whereby we were able to eliminate the slots and today unslotted buckets in solid rotor are AN EXCLUSIVE STURTEVANT FEATURE.

The unslotted bucket is obviously much stronger and permits of a thinner and more efficient vane. Furthermore it is self-evident that the slots encourage leakage from one bucket to the next and this further reduces the efficiency.

The unslotted bucket is just one of the superiorities of the Sturtevant steam turbine. The other advantages are given in detail in our catalogs 209 and 210, copies of which will be sent on request.

Improved Sturtevant Rotor—Cannot be duplicated due to patents.

B. F. Sturtevant Company

of Canada, Limited, Galt, Ontario

MONTREAL TORONTO WINNIPEG VANCOUVER

Selling Agents for Sanford Riley Stoker Co., Limited,
THE RILEY STOKER

Sturtevant

(TRADE MARK)

Steam Costs Money

When you do not save steam after you have generated it you resemble the man who has worked hard to make money and then allows it to slip through his fingers.

Don't waste any more steam—steam is money. Save it by using the COLE RETURN TRAP.

Look for this

Trade Mark

Geo. W. Cole, Limited
838 Dundas Street, Toronto

Machinery Deserves Good Lubrication

The initial cost of good lubrication is negligible when compared with the ultimate cost of poor lubrication.

DIXON'S
GRAPHITE CUP GREASES

have a reputation for quality and service. A perfect mixture of selected flake graphite and mineral grease is the reason.

Let us know your lubricating problems and we will tell you how to solve them.

Write to Dept. 222-R.

Made in Jersey City, N.J., by the

JOSEPH DIXON CRUCIBLE COMPANY

DIXON ESTABLISHED 1827 DIXON

Sole Canadian Representative:
CANADIAN ASBESTOS CO.
Montreal, Que.

TRADE GOSSIP

Granby, Que.—The Southern Canada Power Co. will build a sub-station and office here.

Alvinston, Ont.—Town Council contemplates the installation of an electric lighting system.

Aylmer, Ont.—The Town Council will purchase electrical transmission equipment, motor-driven pumps, etc.

London, Ont.—E. Leonard & Sons, York St., contemplate the erection of a blacksmith shop to cost $20,000.

Prince Rupert, B.C.—The City contemplates extending the water main system which will cost $10,000.

Rosthern, Sask.—The Town Council will install a power plant. The Perry Electric Co. of Edmonton have the contract.

Hamilton, Ont.—The Barton Township Council has decided to submit Hydro-Electric and enabling by-laws to the ratepayers.

St. Mary's Ont.—The Town Council are building an addition to the civic power plant and are in the market for a motor driven pump.

St. Catherines, Ont.—The City Council are considering the purchase of a motor driven sewage pump. W. P. Near is the city engineer.

Bradford, Ont.—A by-law will be submitted to the ratepayers on Oct. 6, to authorize an expenditure of $15,600 on installing a hydro-electric transmission system.

Chapleau Township, Ont.—The Township Council will build an addition to its pumping station and instal an electrically-operated pumping unit to cost $6,000.

Toronto, Ont.—The City Architect has issued a permit to the Hospital of Incurables to install underground fuel oil storage system, 130 Dunn avenue, at a cost of $3,000.

Welland, Ont.—The voltage of the Hydro-electric system here will be increased from 12,000 to 46,000 volts and the equipment in the sub-station is being changed to suit the new service.

Scarborough, Ont.—The Hydro-Electric Power Commission has notified the Township Council that work has been started on a line to go through Birchcliffe, Scarborough Junction and Agincourt. It is hoped to complete the work this fall.

New Toronto, Ont.—Building operations have been already commenced on the new hydro-electric sub-station at the corner of 9th street and Birmingham avenue, New Toronto, by Witchall and

Lethbridge, Alta. — Commissioner Freeman stated recently at a meeting of the City Council that a new steam turbine and generator will have to be ordered without delay in order to provide power for the increasing load. It is estimated that a new unit will cost $50,000.

The Kerr Engine Co., of Walkerville, Ont., valve manufacturers, have leased their iron foundries to the Standard Foundry & Supply Co., who will hereafter make all the grey iron castings for the Kerr firm in connection with their extensive valve and hydrant business, and will also go strongly into jobbing work.

The St. Lawrence Welding Co., of Montreal, have opened up their new brass foundry at 39 Olier Street. The plant is equipped on a large scale with all the latest brass foundry requirements and production of castings has recently been started. The firm has secured the services of Robert Stark, who is one of the best known foundry men in Canada, and who will have charge of the brass foundry under the direction of A. M. Barry.

Brandon, Man.—The sale has been completed of the properties of the Brandon Electric Light Co. and the Brandon Gas & Power Co., to the Canada Gas & Electric Corporation, a company composed of financial interests in the City of Cleveland. G. A. Paterson, who for the last twenty-five years has been managing director of the Brandon Electric Light Co., has been appointed general manager of the new corporation's properties in Brandon.

Ladysmith, B.C.—The smelter which was recently put in operation by the Ladysmith Smelting Corporation, will be capable of handling 1,200 tons of ore per day, although the initial capacity is 700 tons. There are two blast furnaces, one 42 in. x 120 in., and the other 42 in. x 160 in. at the tuyeres. The boiler plant consists of two 80 h.p., one 88 h.p., and one 104 h.p. boilers. Two electric generators furnish power for the motors and lighting system.

Hamilton, Ont.—The following tenders have been submitted in connection with the proposed pumping installation for the Beach Station:—Allan General Supplies Co., $3,715; Canadian General Electric Co., transformers, $14,010; DeLaval Co., centrifugal pumps, $22,420; Canadian General Electric Co.. switching apparatus, $4,990; Canadian Westinghouse Co., motors, $16,620; Babcock & Wilcox Co., boilers and insulation, $17,555; Turbine Equipment Co., steam turbine pumps, $52,517. The original estimate for the pumping equipment was $127,000.

Sherbrooke, Que.—The Southern Canada Power Co. is building 88 miles of high tension transmission lines, connecting up the cities of Sherbrooke, Magog, Waterloo, Granby and St. Johns. It is expected that these lines will be completed this fall. When completed this will give the company over 160 miles of high tension transmissions, principally 50,000 volts. The company have recently purchased property on the main street in Granby, almost opposite the Post Office, and are erecting a new sub-station, office and store for the sale of electrical equipment.

CATALOGUES

The Vanadium Alloys Steel Co., Pittsburgh, Pa., has mailed to the trade the latest stock list of "Red Cut Superior" high-speed steel in warehouses at Pittsburgh, Pa., and Latrolie, Pa.

Reducing Valves.—Bulletin issued by Chaplin-Fulton Mfg. Co., Pittsburg, Pa., describes the "Fulton" steam reducing valve, and also gives directions for setting and operating this device. Two types are illustrated together with prices for the various sizes.

Cheap Steam.—The May issue of the organ "Cheap Steam" has been mailed by Ed. Bennis & Co., Little Hulton, Bolton, England. This publication contains a short descriptive article covering power plants where Bennis stokers are installed and other matter of interest to steam users.

Knudsen Packless Joints.—Bulletin issued by the Universal Valve Co., Burlington, Vt., describing the Knudsen packless swivel joint for iron pipe in steam, gas air or ammonia lines. The advantages claimed for this joint and details of its construction are dealt with fully, while a number of views are included showing applications under various conditions.

The Crane Packing Co., Chicago, manufacturers of the well known "John Crane" flexible metallic packing for all vapors and liquids, announce the establishment of their Eastern office in the Woolworth Building, New York City. Their engineer, A. W. Payne, with much experience with packing problems in the oil, mining and industrial fields, has been placed in charge of this branch.

Radial Brick Chimneys. The Alphons Custodis Chimney Construction Co., New York, have gotten out an interesting bulletin showing a number of tall chimneys which they have constructed, with principal dimensions. The bulletin also contains details of the radial brick used and a copy of Kent's table of size of chimneys for steam boilers.

Pulleystone for Belts.—Bulletin distributed by the National Chemical Works, South Acton, London, England, deals with the material "Pulleystone" for coating main driving pulleys and for other purposes where belt dressing is used. The main advantages claimed for this material are given in detail. Reference is also made to a material named "Permanite" for making joints and repairing cracks in metal articles.

Boiler House Elevators is the title of a 28 page catalogue recently issued by the Ed. Bennis & Co., Little Hulton, Bolton, England. The catalogue after dealing with the advantages of elevating and conveying machinery in boiler plants, proceeds to describe the "Bennis" elevator, drawing attention to its principal constructional features and also to the economies that can be effected by its use. The greater part of the catalogue comprises several very clear views, covering a number of installations showing the wide field of application. A brief description accompanies each illustration detailing the chief points of interest.

The Sanford Riley Stoker Co., of Worcester, Mass., has had such an increased volume of business in the Riley underfeed stoker, that it has arranged for additional manufacturing facilities in Detroit, Mich.

CLASSIFIED ADVERTISING

RATES.

Two cents per word for first insertion. One cent per word for subsequent insertions. Count five words when box number is required. Each figure counts as one word.

WANTED—SHIFT ENGINEERS CAPABLE OF operating Diesel Oil Engine, men with knowledge of Gas Engines and Suction Producer preferred. Write for further information, and state experience, etc., to Box 499, Swift Current, Sask. p10h

FOR SALE—2 RETURN TUBULAR BOILERS —made by Goldie and McCulloch Company of Galt, Ontario, 59 inches diameter by 14 feet, with seventy-eight 3-inch tubes. Complete with all valves and boiler mountings; also 2 complete sets of Jones underfeed stokers, with Robb-Armstrong engine for driving fan. Installation can be seen any time by appointment. Stauntons, Limited, 944 Yonge Street, Toronto. Telephone North 4340.

WANTED

300 H.P. Heine Water Tube Boiler, 150 lbs. pressure, 3½" Tubes, 18 ft. long, second-hand equipment. Good condition.

OLIVER CHILLED PLOW WORKS OF CANADA, LIMITED
HAMILTON, ONT.

FOR SALE

One 22" x 50" Wheelock Engine, left-hand, arranged for direct shaft coupling, with heavy balance wheel 8¼" x 14" x 17'—7" in dia.

Merchants Rubber Factory
KITCHENER, ONTARIO
p1h

This trap can be installed in any position desired as it has two outlets.

This is a remark very often made by users in reference to—

The LONG Patent Steam Trap

Has But One Moveable Part

Valve is actuated by the expanding and contracting of a tube, a motion that is positive and of sufficient force to close the valve against a pressure of two hundred pounds.

The Long Trap is automatic and requires no valves except those which control admission of steam to apparatus to which trap is attached. It is capable of draining from 900 to 1,500 feet of one-inch pipe.

There are other superior points about the Long Steam Trap. as it could be used as a condenser for heating water for washing bottles, etc., and still remain a trap. Let us tell you the complete story of this wonderfully successful power house facility.

Write.

J. T. LONG
84 Adam Street
MONTREAL, CANADA
If your dealer does not sell it, write direct.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

Cameron Babbitt Retainer
(Patented in Canada and the U.S.A.)

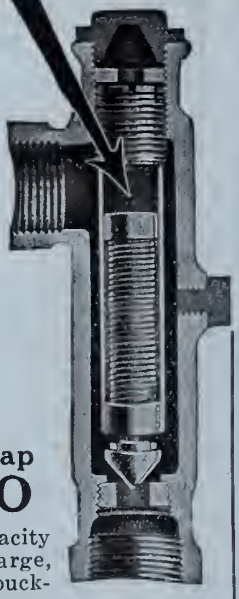
Not like clay or other material, as it does not stick to the work or hands. Does away with using leather or paste-board at end of box. For any metal.

The only satisfactory compound for retaining molten metal and can be used over and over again for months—no deterioration.

For prices and samples apply to

A.S.K. Chemical Company, Elora, Ontario

100% AUTOMATIC STEAM TRAP SARCO OPERATED BY ITS OWN HYDRAULIC PRESSURE CREATED HERE



In addition to the increasing costs of fuel—the scarcity of supply and difficulty of delivery add to the necessity for saving.

Put one of these wonderful little, highly efficient 100% automatic steam traps on every steam line.

The Steam Trap SARCO

has equal capacity with the large, cumbersome bucket or float traps, yet is only slightly larger in diameter than the pipe to which it is attached. It requires no building up nor platform, but may be added as a bend or elbow in any convenient position.

Once installed, the Steam Trap SARCO requires no further care or attention. It operates entirely from the hydraulic force created within the power cartridge inside the trap

The Steam Trap SARCO will save money for you from the start. It costs less, operates automatically and saves steam and fuel.

Will you give us the opportunity to prove our claims.

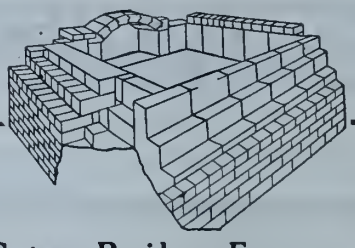
Sarco Company, Inc.

Woolworth Bldg.
NEW YORK CITY
and all principal cities.

Iron Works. There will be no change in the management or policy of the Murphy Iron Works. They will continue the manufacture of the Murphy automatic furnace, increasing their manufacturing facilities as required for the production of Riley stokers. R. Sanford Riley, of Worcester, Mass., has been elected president of the Murphy Iron Works. The B. F. Sturtevant Co., of Hyde Park, Mass., will continue to manufacture and act as selling agents for the Sanford Riley Stoker Co.

Machine Stoking.—A new catalogue entitled "Recent Developments in Machine Stoking," has been issued by Ed. Bennis & Co., Little Hulton, Bolton, England. The opening pages contain a description of the "Bennis" patent improved smokeless chain grate, including matters relating to its durability and draught feature. Following are a number of views showing important installations, each briefly described. The catalogue also contains several sectional views of Bennis chain grates under various types of boiler. An interesting table is shown giving results of tests of this stoker under different types of boiler. The concluding pages contain a table of sizes of Bennis Chain grate stokers and also a table of properties of saturated steam. The catalogue contains 39 pages and is gotten up in attractive style.

SHUNT-WOUND direct-current electric motors are particularly suitable for driving machinery in which the load varies, but which, nevertheless, requires a constant speed. On the other hand, series-wound direct-current motors are not so suitable for belt drives, or where the load is apt to fall suddenly. Differentially wound motors are compound-wound machines, with the series winding arranged to oppose the action of the shunt winding instead of assisting it, as in the normal compound-wound motor, thus giving a speed that is practically constant between no load and full load. With compound-wound direct current motors the speed at no load and full load differs from 15 to 30 per cent., according to the amount of series-winding employed. The advantage of this type of motor is that a larger starting torque is obtained than with shunt-wound motors.



Gates Boiler Furnace
Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

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A great many Canadian Manufacturers say that our claims are facts. We base our claims on a thorough knowledge of the requirements of lubricating oils coupled with scientific preparation. We claim that Kellogg Non-Corrosive Cylinder Oil will eliminate friction; that, owing to its perfect nature the highest efficiency in lubricating is attained; it will last longer, because it is pure, less oiling required; reduces your coal bill very noticeably, because the engines run easier, and every atom of power gives its maximum amount of use. Is your oil living up to your requirements? This Canadian reputation is founded on long experience.

NON-CORROSIVE CYLINDER OIL MANUFACTURED ONLY BY E. M. KELLOGG & CO. Nos. 242 & 244 SOUTH ST. NEW YORK, U.S.A.

WALTER J. FRANCIS, C.E. M. Can. Soc. C.E. M. Am. Soc. C.E. M. Inst. C.E.
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Limited
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Engineers, Manufacturers and Erectors of Steel Structures

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A thoroughgoing job of protection for machinery, walls and floors achieved with various "R.I.W." Protective Products as described below.

A Power Plant To Be Proud Of

Every machine in the Waukesha Brewery is coated with "R.I.W." Machinery Enamel. It is the spick and spannest looking outfit a power house engineer ever had the pleasure of seeing, thanks to

R.I.W. REMEMBER ITS WATERPROOF — REG. U.S. PAT. OFF. **PROTECTIVE PRODUCTS**

The Waukesha Brewery has floors that will not disintegrate or "dust" and cause injury to machinery bearings. These floors are protected and given a fine appearance by the use of "R.I.W." Cement Filler and Cement Floor Paint. (Patented as to Portland Cement, Feb. 27, 1906). They are impervious to oil, grease, water, acids or alkalies.

The walls are damp-proofed with No. 232 "R.I.W.," and are further protected and decorated with "R.I.W." Liquid Konkerit. (Pat'd as to Portland Cement Feb. 27, 1906.) The woodwork is made time and fume-proof with sanitary, beautiful "R.I.W." Hospital and Laboratory Enamel.

All steel work is protected with No. 49 "R.I.W.," and all other metal work with "R.I.W." Aluminum Bronze.

Then, to finish up this model of protection against all forces of corrosion and disintegration, all wainscoting in the engine room and brew house is decorated and preserved with "R.I.W." Flex-Sicco Ready Mixed Paint.

This plant is worth any power man's study. Write for our literature, Dept. 59.

Manufactured in Canada by

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Technical and Scientific Paint Makers since 1848

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Agents in Vancouver, Winnipeg, Edmonton, Calgary, Montreal, Quebec, St. Johns.

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REMEMBER ITS WATERPROOF

REG. U.S. PAT. OFF.

STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

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FOR

Immediate Delivery

We have in stock at Montreal and Toronto the following motors:

3 Phase		60 cycle
1—	½ H.P.	110 volts
2—	1 "	550 "
2—	1 "	220 "
1—	1 "	110 "
6—	2 "	550 "
1—	2 "	220 "
6—	3 "	550 "
2—	3 "	220 "
6—	5 "	550 "
4—	5 "	220 "
7—	7½ "	550 "
1—	7½ "	220 "
24—	10 "	550 "
2—	10 "	220 "
7—	15 "	550 "
1—	15 "	220 "
1—	20 "	550 "
5—	25 "	550 "
1—	25 "	220 "
2—	30 "	550 "
2—	40 "	550 "
1—	50 "	550 "
2—	75 "	550 "

3 Phase		25 cycle
2—	1 H.P.	220 volts
1—	2 "	550 "
3—	3 "	550 "
1—	7½ "	550 "
1—	10 "	550 "
3—	15 "	550 "
3—	20 "	550 "
2—	30 "	550 "
2—	35 "	550 "
1—	75 "	550 "

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CFM

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs*. Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

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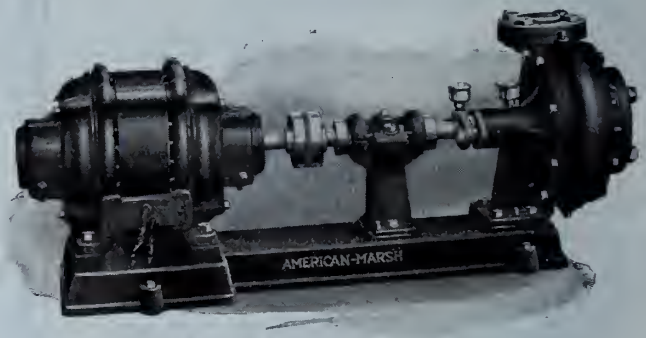
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

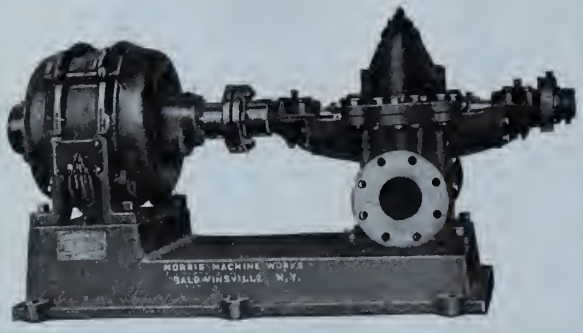
American Steam Pump Company

Battle Creek, Mich.



American-Marsh Centrifugal Pump.

Morris Pumps



The horizontal shaft double suction pump illustrated above was designed to meet the demand for a high efficiency pump. It is also built multi-stage in sizes from 2" to 20" discharge.

Our 126 PAGE MORRIS BOOK is free. Better send for it—To-day.

Morris Machine Works Baldwinsville, N.Y., U.S.A.

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Canadian Sales Agents:
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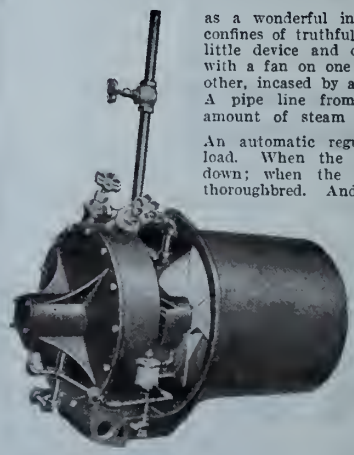
"Doing Our Bit"

We believe we are "doing our bit" in demonstrating to manufacturers how they can effectively cut down the cost of steam production, better their combustion and increase the capacities of their boilers. In offering the

Coe Turbine Blower



as a wonderful invention, we are well within the confines of truthful advertising. It is such a simple little device and does such a big work! A shaft with a fan on one end and a steam turbine on the other, incased by a shell is about all there is to it. A pipe line from the leader supplies the small amount of steam required.

An automatic regulator adjusts the speed to the load. When the load is light, the blower slows down; when the peak comes it responds like a thoroughbred. And how it does drive the air into the fire! Clinker doesn't get a chance to form.

The gases of combustion which ordinarily pass up the chimney are held back by the draft controller, thoroughly mixed with the air and burned. Nothing gets away that is worth keeping.

Space limits prevent a complete description of the Coe Turbine Blower. Write for it and receive our special demonstration proposition. You should have it. We solicit your inquiry.

C. T. COE COMPANY

Engineers and Combustion Experts

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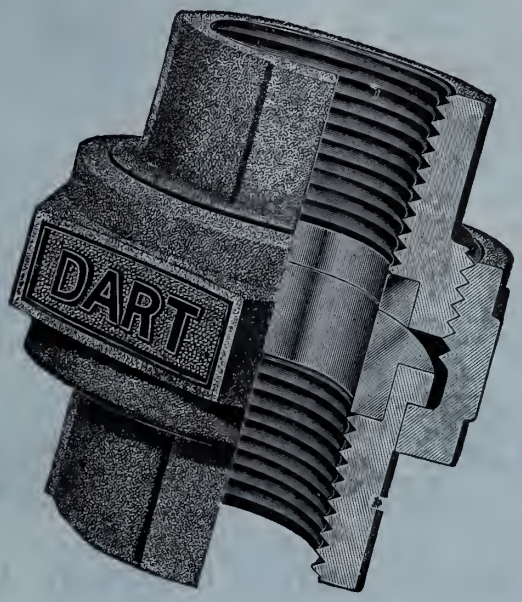
DART



Bronze to Bronze at the joint

No Rust No Corrosion

UNIONS

Whether pipes are in or out of line, the ball-shaped seat of Dart Unions makes easy connections possible—and sure.

Saves loss from leaks, upkeep and replacement costs. They're Bronze to Bronze at the joint.

Your jobber sells Dart Unions.

Made in Canada by

DART UNION COMPANY, LIMITED

TORONTO, CANADA

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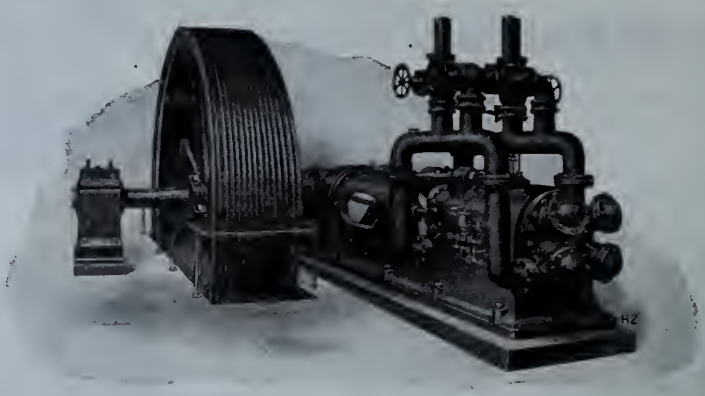

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Many of our machines have been in constant operation for over a quarter century, producing the same capacity, and more in some cases, than their guarantee at the time they were installed. May we give you the names of the owners of these machines?

Let us give you the advantage of our 35 years' experience in all lines of refrigeration without obligation to you.

Write us before buying your next plant or making alterations to your present one.

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ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives:
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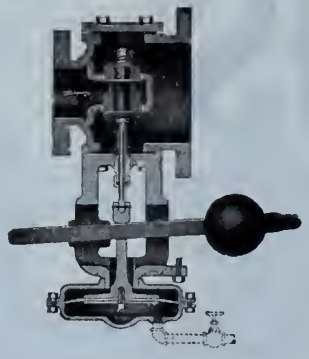

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Regulating Valves
Back Pressure Valves
Pump Governors
Separators
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FOR EVERY SERVICE

SALES ENGINEERS

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FOR THE CORNERS

When a bolt or nut is hard enough to reach to be called "INACCESSIBLE," you need a

Starrett RATCHET WRENCH

There are many "INACCESSIBLES" around the power plant, but this wrench, with reversible pawl, universal joints and extensions, makes quick work of them.

Send for catalog No. 21CD, which also describes speed indicators, hack saws, tapes and other tools.

THE L. S. STARRETT CO.
The World's Greatest Toolmakers
ATHOL, MASS. '42-730

Jefferson Unions

The *Dependable* Pipe Connections

No matter where you put a Jefferson Union, whether it be on an air line, a steam line, a gas line, or oil line—it's "on the job" at the last turn of the wrench. You can forget its existence—for it's dependable—it will keep energy where it belongs, in the pipes. There are numberless styles of Jeffersons—one for every kind of connection. And there are two types, one with brass-to-iron ball seat and one with iron-to-iron seat for where the prevention of corrosion is not essential.

You had better get the Jefferson Book "Unions" —the coupon below mailed to-day will bring it to you at once.

Jefferson Union Company
LEXINGTON, MASS.

Jefferson Union Co., Lexington, Mass.
Gentlemen: Mail me postpaid and without any obligation to me, copy of your New Catalog.
Name.....
Firm Name.....
Address.....
P.H. 10-17

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KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Double Protection

Tight blow-off connections are essential to economy. You get double protection against heat waste using—

THE HOVALCO
Angle Blow Off

and the

HOMESTEAD
Quarter-turn Valve

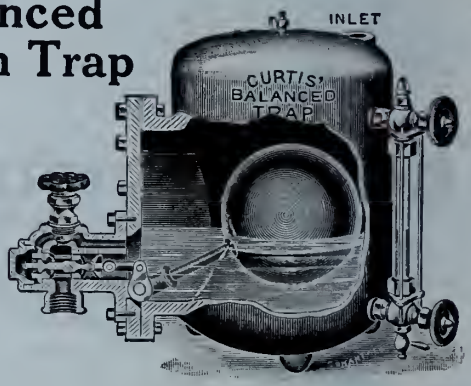
This combination is conceded to be the best idea in valve construction of a generation. Try them and note well their faultless service.

HOMESTEAD VALVE MFG. CO.

Works: Homestead, Pa. **Pittsburgh, Pa.**

GURTIS Engineering Specialties

Balanced Steam Trap



This trap is often used as a waterline trap on large plants where there is need to balance any particular circulation to prevent snapping and cracking in pipes and radiators.

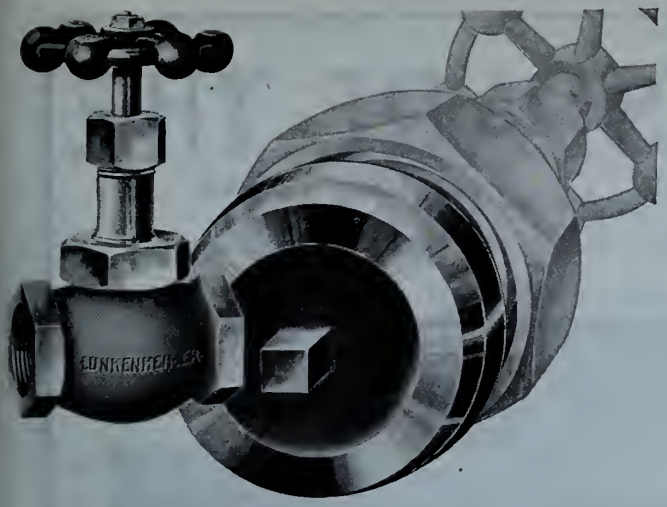
This Trap Has These Points of Difference and Superiority

1—A perfectly balanced valve.
2—An absolutely frictionless valve.
3—The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4—The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5—Each trap will operate perfectly on pressure varying from one to 250 lbs.

The great merit of this trap, its simplicity, its dependability and serviceability make it well worth being better acquainted with. Send for special printed matter describing it and giving prices. Address the Manufacturers.

JULIAN D'ESTE COMPANY
Main Office, 26 Canal St., Boston, Mass.

Agencies: 216 Faulton St., New York City; 174 N. Market St., Chicago, Ill.



Repairs?
—simply regrind the seating surfaces

and a Lunkenheimer Regrinding Valve is as tight as when new.

The exceptional wearing qualities of this valve are well known to the trade. Its metal to metal seat—ground to a tight fit, forms an ideal seat to resist the inevitable wearing action of steam at its high velocity. And the fact that the seating surfaces can be *reground*—an inexpensive operation easily accomplished, makes the renewal of parts with the cost it entails, wholly unnecessary.

The Lunkenheimer Regrinding Valve is truly an economy valve. All the parts are designed to resist wear—they are generously proportioned, the machining is accurate and the composition for the different parts varies according to the duty the part performs.

The threads are long and cut perfectly true. The stuffing box is provided with gland follower on sizes above one-half inch and is packed with a moulded asbestos ring packing which is exceptionally durable. Should necessity require it can be repacked while under pressure and wide open.

Made in a variety of types, including Globe, Angle and Cross, with Inside Screw and with Outside Screw and Yoke. Also Horizontal, Angle and Vertical Check Valves.

We cannot make all, but—we do make the best

Your local dealer can supply you; if not, write us. Write for descriptive booklet No. 517-DC.

THE LUNKENHEIMER CO.
—"QUALITY"—

Largest Manufacturers of High-Grade Engineering Specialties in the World

CINCINNATI, O., U.S.A.

New York Chicago Boston London

Lunkenheimer Regrinding Compound furnished in collapsible tubes is a time and labor saver. It should be in every Engineer's tool kit.

3-14-43

VALVES

BRASS
OR
IRON BODY
SCREWED
OR
FLANGED

Suitable
FOR
STEAM,
WATER,
GAS,
AIR,
ACID or
OIL

Sizes
¼" to 12"
Carried
in Stock

For
Pressures
125 to
500 lbs.

GLOBE, ANGLE, CHECK and GATE

T. McAVITY & SONS
LIMITED

Hardware and Metal Merchants

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ST. JOHN, N.B.

MONTREAL TORONTO WINNIPEG
LONDON, ENGLAND

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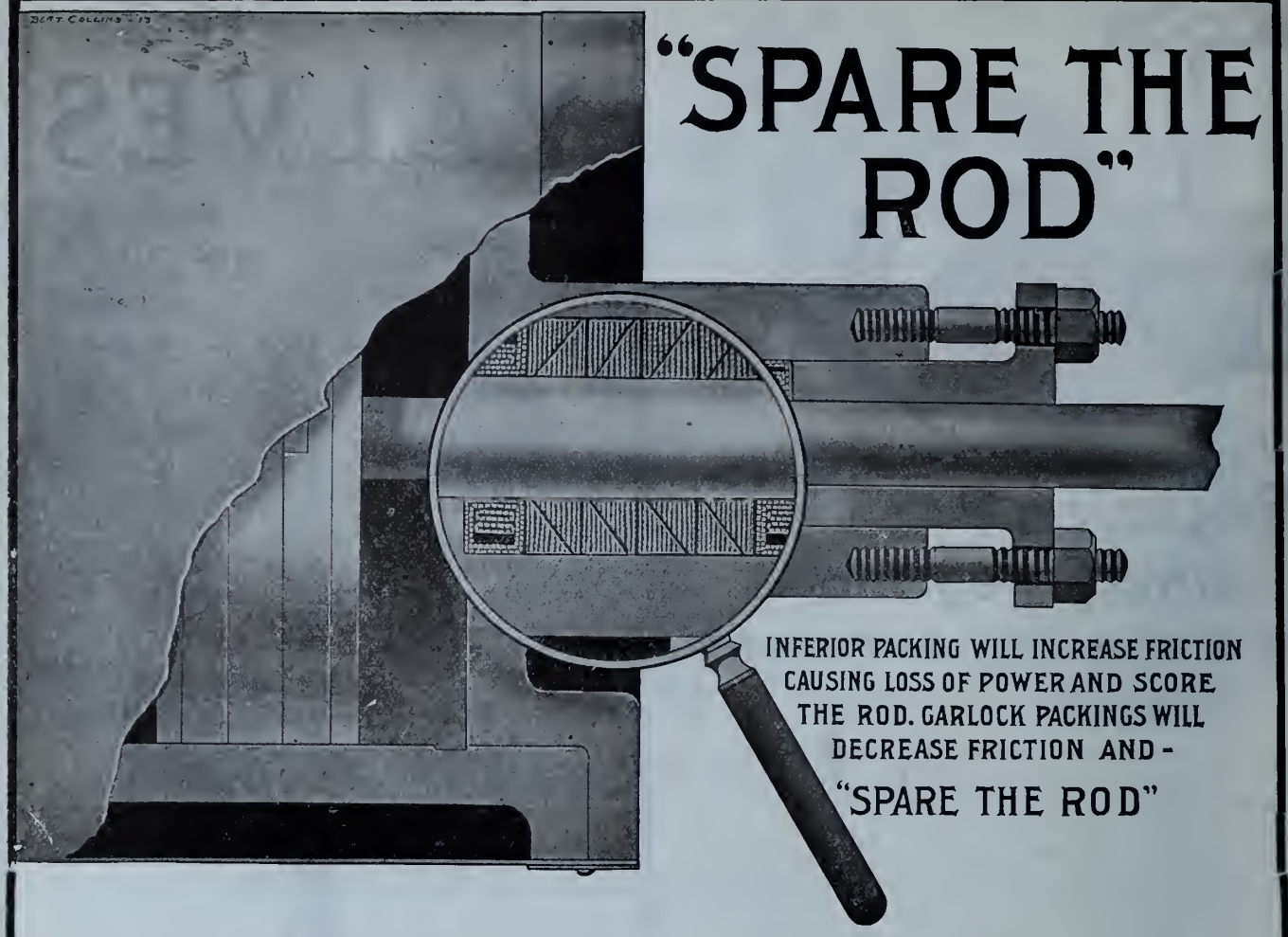
"SPARE THE ROD"
INFERIOR PACKING WILL INCREASE FRICTION CAUSING LOSS OF POWER AND SCORE THE ROD. GARLOCK PACKINGS WILL DECREASE FRICTION AND -
"SPARE THE ROD"

Have You Ever Considered the Loss in Engine Efficiency

due to excessive friction on piston and valve rods caused by the use of inferior and poorly lubricated packing?

A horsepower easily can be absorbed at the stuffing box, and when considered in dollars and cents at the coal pile, the loss would pay for a high-class packing many times over.

The Garlock Packing Company - Hamilton, Ont.

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IT STANDS FOR

Service - - Anchor, Steam and Hydraulic Packings

Quality - - Canuck Hot Iron Front End Paint

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Reliability - Brubaker Staybolt Taps

Durability - O'Malley-Beare Multiplate Valves

Efficiency - Vim Belting

If any advertisement interests you, tear it out now and place with letters to be answered.

"Maple Leaf" Brand

Stitched Cotton Duck Belting

THE BEST FOR ALL KINDS OF BELTS

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.

Dominion Belting Co., Ltd.,
HAMILTON, CANADA

SAFETY PLASTIC
METALLIC PACKING
FOR STEAM, WATER, AIR, GAS, ETC.

Self-Lubricating

In Bulk

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

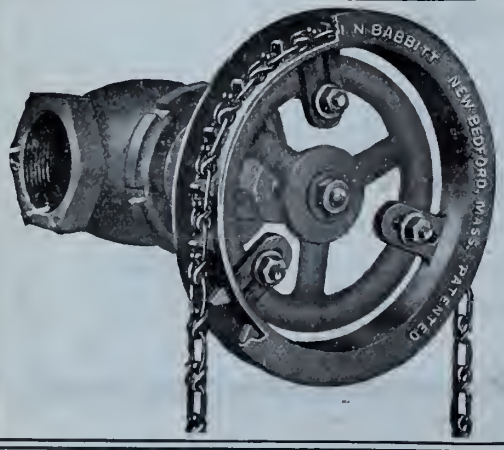
GUARANTEED TO LAST THREE YEARS
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

Practically Frictionless

In Cotton Tubes



The Ladder Is Always In the Wrong Place And It Has a Habit of Slipping

The Babbitt Adjustable Sprocket Rim

Is SURE To Be In the Right Place and CAN'T Slip

That's the difference between wasting time and saving it—between broken bones and whole ones—between prompt action when promptness means safety, and the delay that spells danger. Nothing like it for opening or closing the out-of-reach valves. The price won't stand in your way for a minute. Ask your dealer. Send us his name and ask for Illustrated Folder.

Babbitt Steam Speciality Co., 59 So. Water Street
NEW BEDFORD, MASS.

Manufactured in Canada, under Canadian Patent, by the Engineering Specialties Co., Ltd., 1080 King St. West, Toronto, Ont., Canada.

This Mark On Belting

STANDS FOR

Flawless Back Leather British Oak Tanned

and all that this famous process signifies

It is our mark of dependability and it appears on every piece of our genuine British Oak Tanned Leather Belting—a guarantee that every inch is flawless back leather.

Many of Canada's largest and best-equipped industrial and power plants know from using our Belting that this distinguished service mark means:

Belting Trouble Economically Solved

We want you to know all that this trade-mark stands for: The selection of hides by experts; the process of British Oak tanning the flawless back leather so that every bit of the hide's natural strength is preserved; the building and shaping of the belting itself; the painstaking inspection of all belting before it is pronounced worthy to be stamped with our "Genuine Oak" trade-mark.

We want you to know how good our belting is—how good users say it is. The coupon will bring you convincing particulars.

D·K·McLAREN LIMITED

HEAD OFFICE AND FACTORY:
351 ST. JAMES STREET, MONTREAL, P.Q., CANADA

TORONTO, ONT.	ST. JOHN, N.B.	VANCOUVER, B.C.
194 King St. West	90 Germain St.	847 Beatty St.

D. K. McLAREN, Limited,
Gentlemen,—Please put me in touch with some users of your belting.

Name .....

Address .....

Firm ..

If any advertisement interests you, tear it out now and place with letters to be answered.

Man-Size Conversation

Something about Jones---The Test Question that Silenced Jennings---Where Jones gets the information that makes him listened to when he speaks.

AFTER the little group had finished their cigars, and were about to separate, each going his own way, Brown said to Smith: "Wasn't Jones great? And didn't he put it all over Know-It-All Jennings?"

It was just such a group of men as you see gathered every day round a luncheon table, or in the club lounge; and the theme of the conversation was likewise common enough—the present business situation, and the probable situation when Peace is made.

At first every man had opinions to declare, but most of all Jennings. Jones was, at the beginning, the silent one. But at a point when Jennings, with his usual cocksureness, was voicing some extravagant views, Jones rather jolted him by asking him, "What is your authority?" And Jennings didn't have authority—nothing more than opinions.

It was then that Jones began to talk, and his tactful, well-informed views and statements instantly commanded the attention of every man round the table; for every man was learning. Even Jennings had the grace of keep quiet, for he knew he was listening to a better-informed man.

Jones has a staggering question to put to men with opinions which they express boldly and confidently. It is: "What is your authority? Your opinions are no better than your information." The average man expressing opinions doesn't possess much solid information; he just "feels" that way.

Every man not an idler is interested in Business—first, in his own business; second, in the Nation's business. Whether he be a retailer in a country town; or a manufacturer; or a lawyer advising clients on investments; or a bond-dealer needing to know much about the many factors that affect prices; or a banker; or a private investor whose funds, invested or waiting investments, are his main source of income; he is interested in Business, and he needs information—the real stuff which is the basis of opinion.

Where can each get the kind and amount of information desired?

Let him get it where Jones gets much of his information —from THE FINANCIAL POST OF CANADA.

Jones does a good deal more than just pay $3 to get this paper every Saturday; he *reads* it. To him the POST is the newspaper prized most of all. He sets aside a certain set time each week for reading it. It satisfies him because its views are based on information, and information is the POST'S chief material.

The POST keeps Jones soundly and broadly informed about the business affairs of the country. He finds that the POST takes a business-like view of all questions; that it is not influenced by any political factions or "interests," that it tells the truth whether the readers like it or not. He knows that little of importance will occur in connection with the business of the country without enlightening information or comment appearing in the POST.

He gets the best-informed news about listed and other securities, in the POST:—Milling, Transportation, Pulp and Paper, Iron and Steel, Electrical Enterprises; and so on. This weekly Security News he finds is of an authoritative character —usually signed—prepared by specialists, who, from the nature of their daily work, are in intimate touch with the factors that affect prices, and with high-up or well-informed men who have *knowledge.*

Jones finds no other paper in Canada attempting to give the service the POST does in relation to listed securities.

Jones finds the POST'S editorial page stimulating. He enjoys the biographical stories of Big Men which appear in the POST. The article each week by Agnes Laut gives him information gathered by one of the best informed and highest paid writers in America. In short, for Jones the POST is a treasury of information about Business; and it is Business by which Jones earns his bread and butter and something more.

When Jones mingles with his fellow men, and Business is the Theme of Conversation, most men are willing to listen to him, because his opinions are based on sound and reliable information.

Now, what is the application of all this? It is that you, the reader of this advertisement, may also make yourself a well-informed man about *Business—by reading THE FINANCIAL POST.* The $3 it costs per year is neither here nor there to the man who really wants to *know*—to have knowledge about matters and markets pertaining to his own business; and about the Country's business.

If you want your opinions to be well-informed; if you want a wide knowledge of Business; let the POST go to your home each Saturday. Sign the coupon below. Send no money now. Have the bill go forward in the usual way.

The Financial Post OF CANADA

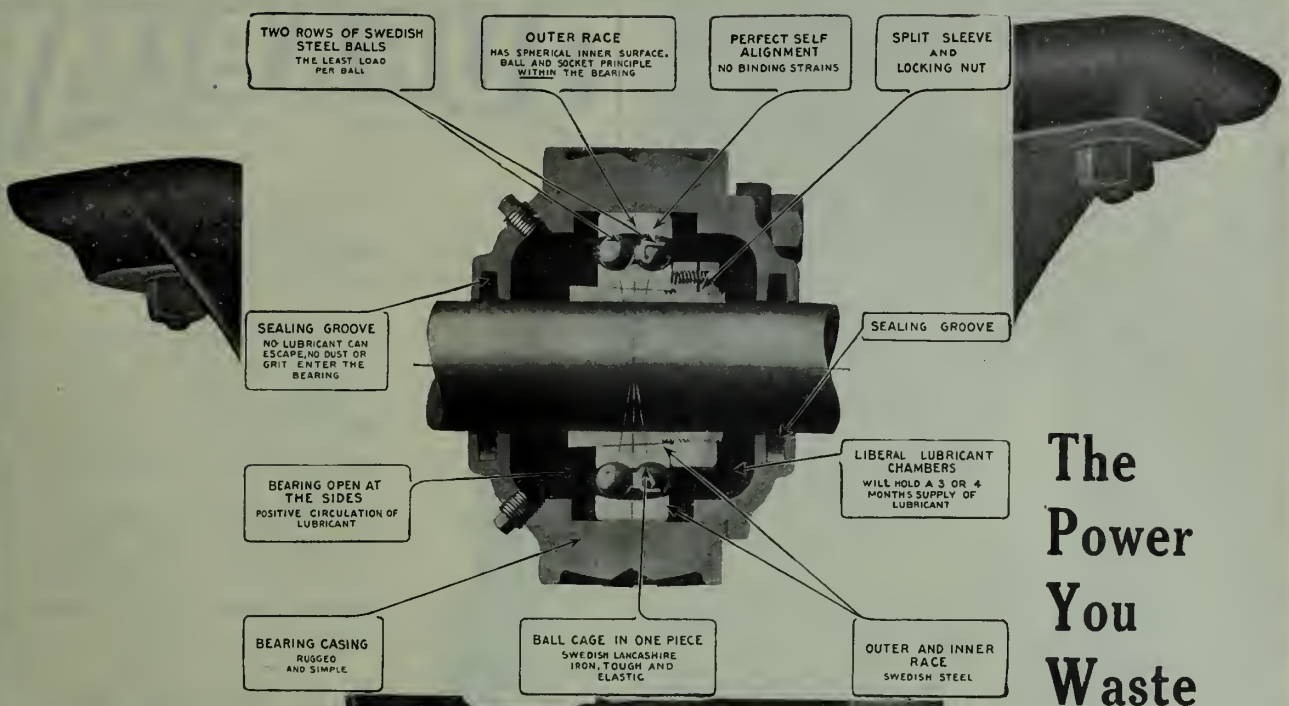
The MacLean Publishing Co., Ltd.,
143-153 University Ave., Toronto.

Send me *The Financial Post,* for which I will pay $3.00 per year on receipt of invoice.

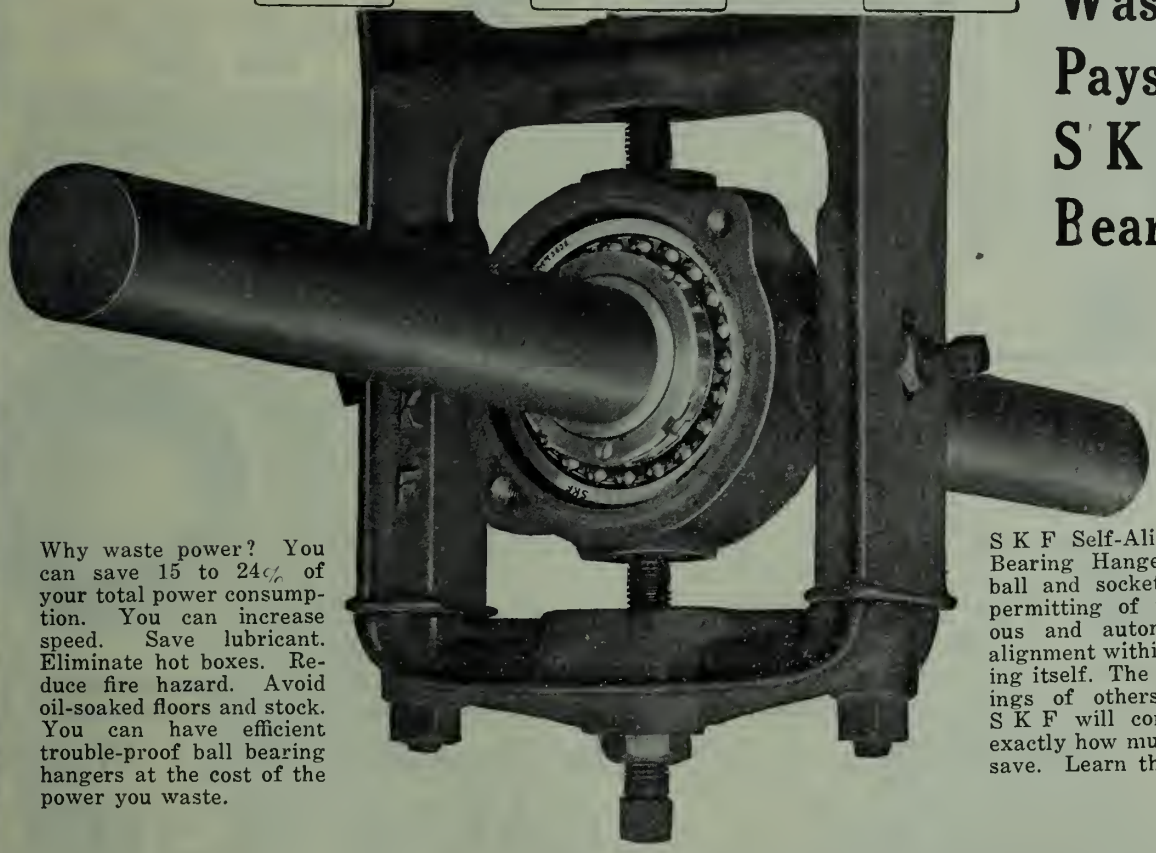
Name..... Address.....

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS


TWO ROWS OF SWEDISH STEEL BALLS
THE LEAST LOAD PER BALL
OUTER RACE
HAS SPHERICAL INNER SURFACE, BALL AND SOCKET PRINCIPLE WITHIN THE BEARING
PERFECT SELF ALIGNMENT
NO BINDING STRAINS
SPLIT SLEEVE AND LOCKING NUT
SEALING GROOVE
NO LUBRICANT CAN ESCAPE, NO DUST OR GRIT ENTER THE BEARING
SEALING GROOVE
LIBERAL LUBRICANT CHAMBERS
WILL HOLD A 3 OR 4 MONTHS SUPPLY OF LUBRICANT
BEARING OPEN AT THE SIDES
POSITIVE CIRCULATION OF LUBRICANT
BEARING CASING
RUGGED AND SIMPLE
BALL CAGE IN ONE PIECE
SWEDISH LANCASHIRE IRON, TOUGH AND ELASTIC
OUTER AND INNER RACE
SWEDISH STEEL

The Power You Waste Pays for S K F Bearings



Why waste power? You can save 15 to 24% of your total power consumption. You can increase speed. Save lubricant. Eliminate hot boxes. Reduce fire hazard. Avoid oil-soaked floors and stock. You can have efficient trouble-proof ball bearing hangers at the cost of the power you waste.

S K F Self-Aligning Ball Bearing Hangers on the ball and socket principle, permitting of instantaneous and automatic self-alignment within the bearing itself. The actual savings of others who use S K F will convince you exactly how much you can save. Learn the facts.

If you are having transmission troubles and wasting power needlessly—if you want to have a cleaner, better-looking shop—use S K F.

We will gladly send you complete literature and letters from some of the big S K F users. Ask us to send you the "EVIDENCE."

The Canadian Fairbanks-Morse Co., Limited

SOLE CANADIAN AGENTS FOR SKF TRANSMISSION BEARINGS

St. John Quebec Montreal Ottawa Toronto Hamilton
Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

DURABLA

No defects in manufacture pass these men, who inspect every sheet.

The Durabla sheet is a quality sheet, and we guarantee every gasket cut from it to make a permanently tight joint.

Only quality promotes Efficiency. Only standardizing on the best proves true economy.

Durabla Mfg. Co.
NEW YORK
Distributors for Canada:
The Canadian Fairbanks-Morse Co., Limited

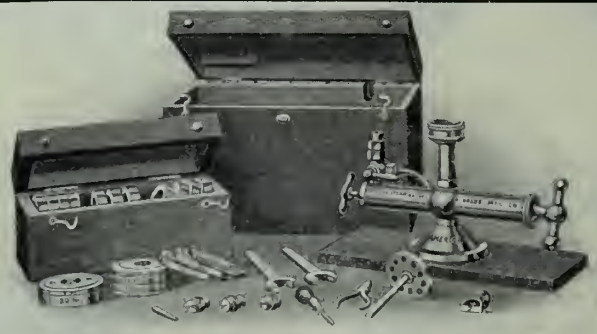
MARTELL PACKINGS MEAN MORE POWER

Give them a Chance to Prove their Worth!

"I gave Martell Packing a trial just to see what it would do and got a big surprise. I didn't really expect it to be much different, if any, from those I had been using, but Martell Packing is far ahead and is giving the best all-round service of any packing I have ever used. I'm going to keep on using it."

This is the gist of what power house engineers in various parts of the country are saying of **Martell Packing.**
Why not give it a trial like others have done; like others, you'll be glad of it, too. **Free demonstration.** "We make metal packing for every purpose."

The Martell Packings Co., Inc. ELYRIA OHIO
Canadian Agents: **The CANADIAN FAIRBANKS-MORSE CO., Limited**



The American Dead Weight GAUGE TESTER

SIMPLIFIES

Power Plant Gauge Testing

PREVENTS EXCUSES! ORDER YOURS TODAY

Canadian Agents:
CANADIAN FAIRBANKS-MORSE CO., LTD., Montreal, Toronto, St. John
AMERICAN STEAM GAUGE & VALVE MFG. CO., New York, Chicago, BOSTON, Atlanta, Pittsburgh

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

KEEP THE PLANT RUNNING SMOOTHLY

Take no chance with a packing that is liable to fall down at any moment.

For long, reliable service, use

"PALMETTO" ☐

the packing that is heat resisting and with lubricant in each single strand.

We will send you working samples to prove it's the packing you ought to use. No charge.

GREENE, TWEED & CO.

Sole Manufacturers

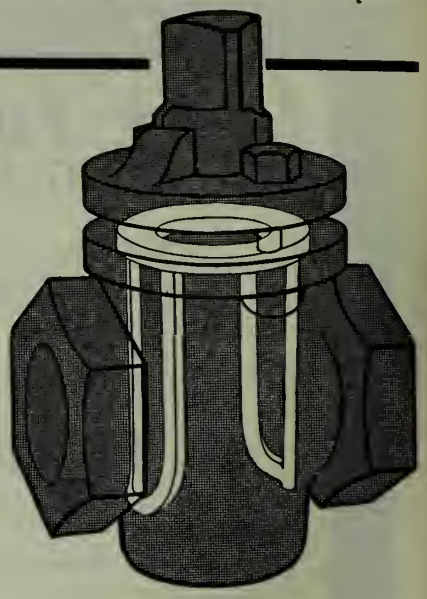
109 Duane Street NEW YORK

Representatives in Canada: The Canadian Fairbanks-Morse Co., Limited, Toronto, Moutreal

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

Groove Packed Asbestos Keeps it Tight—



Elastic and enduring, the asbestos packing bearing against the plug, insures for the

Pratt & Cady Asbestos Packed Iron Cocks

a tight joint under the most difficult of pipe line conditions.

It has proved itself on boiler blow-off as well as on other boiler service and through its enduring tightness has brought satisfaction to hundreds of users for hydraulics and on ammonia, steam, gas, oil and air lines generally.

Put your toughest job up to a P & C Iron Cock. Write us for full information and catalog.

PRATT & CADY COMPANY, INC.
Makers of Valves, Cocks, Steam Traps and Hydrants
Hartford, Conn.

GENERAL SALES AGENTS

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED
St. John Quebec Montreal Ottawa Toronto Hamilton Winnipeg
Saskatoon Calgary Edmonton Vancouver Victoria

Expansion Trouble
Tube Trouble
Scale Trouble
GONE

The Result of Alberger Heater Design

A movable section containing the hot water tubes, expands independently from the movable section containing the cold water tubes. Simple? Yes—and one of the biggest Alberger Improvements over ordinary closed heater design. Easily a single tube can be taken out, if necessary. Nor is there need to break water and steam connections to secure access to the heating surface; these connections are on the body of the shell. Body of heater is built of highest grade cast iron, and the corrugated tubes are copper.

Write to-day for catalog illustrating both horizontal and vertical types.

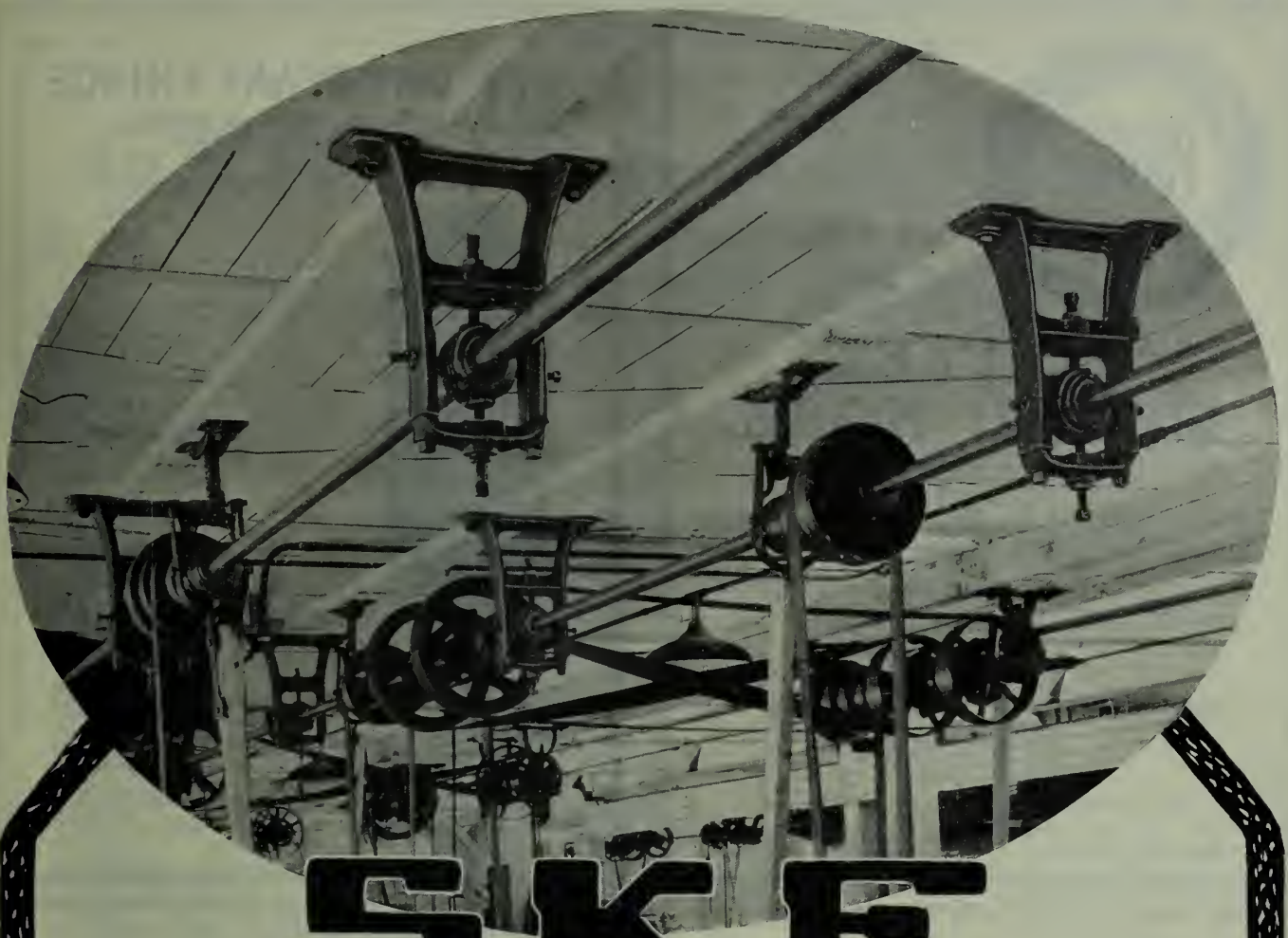
Alberger Heater Company
Buffalo N.Y. U.S.A.

General Sales Agents:

Canadian Fairbanks-Morse Co., Ltd., St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS



SKF

BALL BEARING HANGERS

Six Months on One Oiling

To oil hangers but twice a year is a persuasive argument—a vast amount of oil, trouble and labor are certainly saved.

But do not overlook other savings. Think what the SKF oil-tight housing means—no oil-soaked belts, no oily floors, no goods spoiled in process by oil, reduced fire risk. Think of the safety to your employees, who no longer have to climb among moving belts, shafts and pulleys. Think of the greatest saving of all-bearing friction reduced 60 to 80%—a saving of 20 to 35% on total power.

Let us give you the service record of SKF made in scores of Canadian plants. Let us refer you to users near you. We would welcome the opportunity.

CANADIAN SKF COMPANY, LIMITED, Toronto, Ontario

SALES AGENTS:

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

St. John Quebec Montreal Ottawa Toronto Hamilton Windsor Winnipeg Saskatoon Calgary Vancouver Victoria

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.

Philadelphia, Pa.

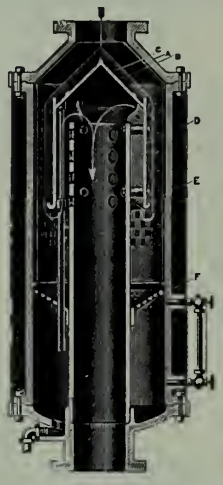
Canadian Agents:

The Canadian Fairbanks-Morse Co., Limited

St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. **THE PLAN**—Is it sensible, will it work, no matter how large the Separator or how well made?

II. **THE SIZE**—Is it big enough regardless of plan, will it hold a good dose of water?

III. **THE CONSTRUCTION**—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY

820 Geddes Street - SYRACUSE, N.Y.

General Sales Agents:

Canadian Fairbanks Morse Company, Limited

St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

Wanted—

Engineers to contribute to Power House

THIS is a practical paper for practical engineers. It is an educational medium and out to help its readers. It is a technical school and a social meeting place combined. It is first, last and all the time an engineer's paper.

If you should meet two or three or a dozen of your brother engineers you would swap ideas—you'd tell of some idea you had worked out in your plant. Others would describe some pet schemes they had devised. And so you would be mutually benefited.

Why not make Power House your monthly meeting place? Why not describe in this paper some kink or scheme you have worked out and found successful? We will pay you for it and you, in turn, will be multiplying the usefulness of your idea five thousand fold!

Never mind polishing up your letters—just give us the idea; that's the main thing. Never mind how crude your pencil sketch may be. We have draughtsmen who will finish up your drawings so they may be reproduced.
Try this idea a time or two and see how much satisfaction you'll get out of it. Start the ball a-rolling and thus help other engineers, yourself and your paper.

POWER HOUSE, 143-153 University Avenue, Toronto

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

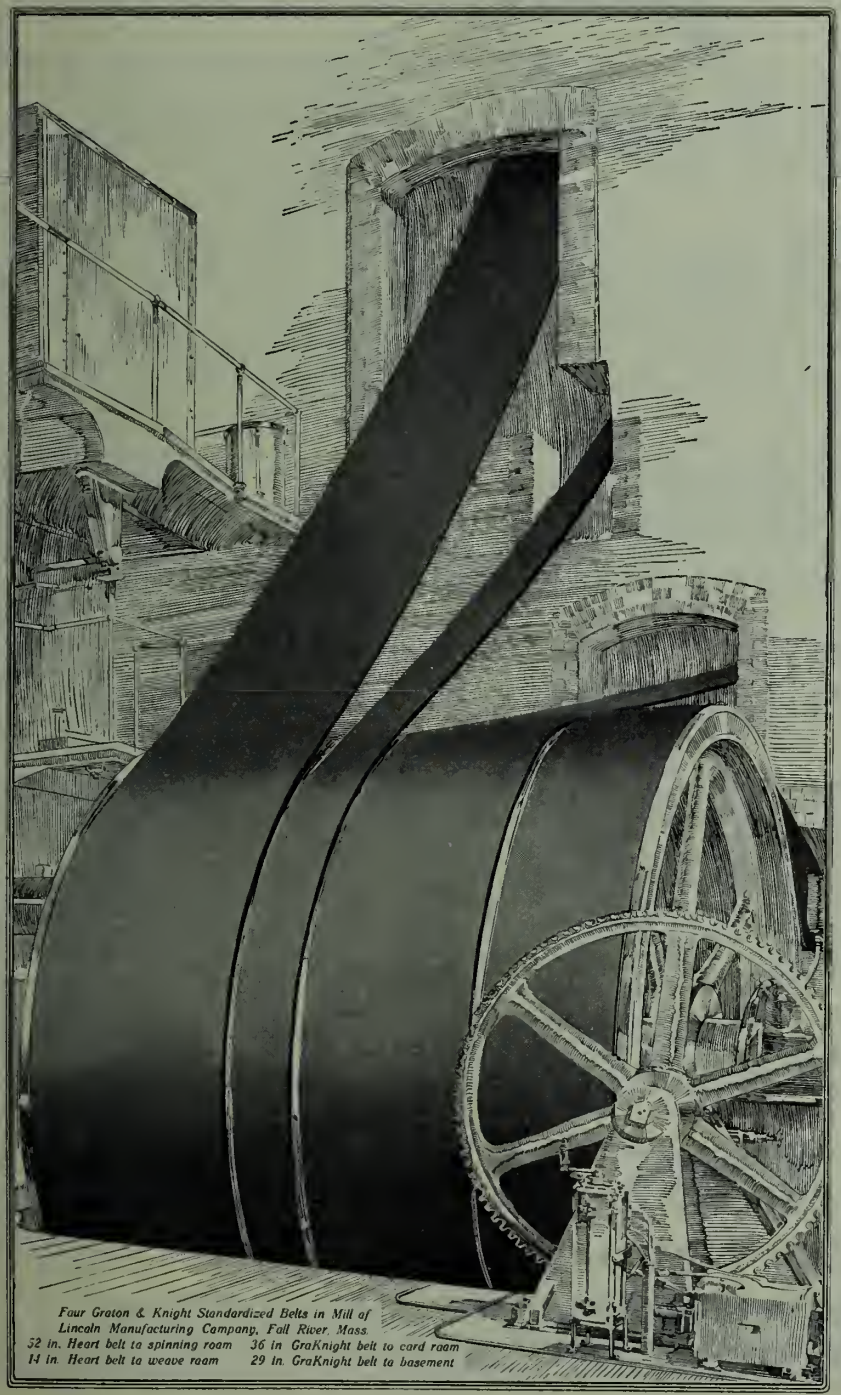
CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

GRATON & KNIGHT

Standardized Series

LEATHER BELTING

Tanned by us for belting use



Four Graton & Knight Standardized Belts in Mill of Lincoln Manufacturing Company, Fall River, Mass.
52 in. Heart belt to spinning room *36 in GraKnight belt to card room*
14 in. Heart belt to weave room *29 in. GraKnight belt to basement*

Big Belts— For Big Jobs

There is one right way, and only one right way, to buy belting. That is on the basis of the *work to be done*. A big job needs a big belt.

If you buy it as you buy machinery — you will standardize it, as you have standardized your machinery. You will buy Standardized Belting.

Standardized Belts are made to the actual standards of the job. They have been worked out during sixty-six years of belting experience. The requirements of every kind of power transmission have been classified and a Standardized Belt evolved to meet the actual demands of each.

There is Graton & Knight Heart Brand, the standardized extra-heavy oak-tanned center stock belt — GraKnight, the standardized, medium-weight, oak-tanned center stock belt — GraKnight Dynamo, the standardized, light-weight, oak-tanned center stock belt—Neptune, the standardized, water-proof belting — Spartan, standardized for exacting conditions or difficult drives.

The way to save money on belting isn't to buy cheaper belts—but to buy the belt that will do your work best.

Apply Standards to your power Transmission. Our Engineers are at your service—let them help you standardize your belting.

The Graton & Knight Mfg. Company

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packings and Sundries

Worcester, Mass., U.S.A.

Canadian Representatives: The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Edmonton, Vancouver, Windsor, Winnipeg, Victoria.

GRATON AND KNIGHT

OVER 50,000 COPIES PER MONTH

Canadians

should be thankful that our Country has a Canadian Magazine fit to take its place in the company of the big American magazines — a magazine equalling in interest and literary merit the big magazines produced in a Country of 100,000,000, where it is possible to obtain $1,000 to $5,000 a page per issue or more for advertising space.

THE making of MACLEAN'S MAGAZINE month by month, year after year, has been hard labor. One difficulty was to get the right sort of matter—Canadian in origin and theme. A few years ago our country possessed few writers and artists of trained and high ability. To-day, thanks very largely to MACLEAN'S MAGAZINE, we have men and women writers and artists producing first-class work; they developed when they found a medium demanding a grade of work equalling the best contributors to American magazines. Also, the Canadian writers and artists who were finding a market for their wares in the United States turned to MACLEAN'S when this magazine showed itself to be a sufficient and creditable vehicle for their work.

The future has a good crop of A1 Canadian writers and artists in store, whose work will appear in MACLEAN'S; but consider these names of Canadian men and women who have already "arrived," and whose work appears in MACLEAN'S MAGAZINE:—

Sir Gilbert Parker,	E. Phillips Oppenheim,
Arthur Stringer,	Peter McArthur,
Arthur E. McFarlane,	L. B. Yates,
Stephen Leacock,	Geo. Eustace Pearson,
Robert W. Service,	W. A. Craick,
Alan Sullivan,	H. F. Gadsby,
Agnes C. Laut,	C. W. Jefferys,
L. M. Montgomery,	J. W. Beatty,
"Janey Canuck,"	Arthur William Brown,
A. C. Allenson,	Lou Skuce.

These are some of the names of Canadian men and women—writers and artists—who are doing work of the highest class, acceptable to the hardest-to-get-into publications of the United States. Ten years ago such a Canadian galaxy had no existence.

BESIDES these professional writers and artists—men and women who depend on their pen and pencil and brush for their livelihood—is a big host of others who write only when successfully urged to do so—because they have something to say that is worth saying. These are usually men in a big way of business, or professional men at the top of the ladder, or men and women doing unusual work of a most important sort—often obscurely because they are not self-trumpeters of their achievements or labors. For example, such men and women as:—

THE LATE SIR MORTIMER CLARK
JOHN BAYNE MACLEAN
ERMAN J. RIDGWAY
LORD NORTHCLIFFE
JOSEPH MARTIN, M.P.
BILLY SUNDAY

All these have contributed under their own name or a nom de plume to MACLEAN'S MAGAZINE in the last 12 or 15 months, recognizing that this magazine can give their messages to the whole nation, and to a class of persons whom they wish to reach.

NOBODY who knows MACLEAN'S would ever call it a story magazine, but rather a national magazine—almost a news magazine. Stories there are in every issue—enough of them to satisfy the right and natural desire for romance, adventure, achievement, business, love and intrigue. But the greater part of the contents of every issue of MACLEAN'S MAGAZINE may be called NEWS—NEWS of men and their work and triumphs; news of the nation's work and workers; news of discoveries; news of movements; news of politics; news of the builders and building of Canada. MACLEAN'S, as Canada's National Magazine, prepared for thinking and intelligent men and women, must be an informative and interpretive magazine, must mirror national opinion, record national affairs and developments, and be the VOICE of prophets, statesmen and leaders. MACLEAN'S is a magazine of to-day—a newspaper of a sort, dealing with big news passed over by daily newspapers whose function is the recording of the day's news—passing news; and who leave the fuller statement—the summed-up presentation of things they can but touch on—to MACLEAN'S MAGAZINE.

A Magazine *of* Power

News features of MACLEAN'S MAGAZINE greatly liked by its 50,000 readers are

The Business Outlook—article.
The Investment Situation—article
The Review of Reviews Department.
The Nation's Business.
Women and their work.

These are regular department features appearing in every issue of MACLEAN'S. They are of the nature of surveys or digests, and perform a service welcomed and praised by all readers who aim to keep themselves broadly informed concerning what's doing in Canada and what's being thought and said and done the wide world over.

REVIEW of Reviews is the outstanding feature of MACLEAN'S, in that it gives the best articles, in condensed form, from the best magazines of the world. A staff of trained people read and study the contents of all magazines and select for each issue of MACLEAN'S twenty or more articles which mirror the world's progress and present the changing aspects of world opinion.

IN rounding out this presentation of Canada's National Magazine a brief reference may be made to one large and discriminating and important class of contributors to it—advertisers. Literally hundreds of them employ MACLEAN'S for their advertising, to reach the influential classes represented by MACLEAN'S list of subscribers, and because they get national publicity economically. These makers and producers of goods of national consumption appreciate the fact that a select circulation of 50,000 gives them, among the most important families of Canada, strong local publicity as well as broad national publicity, and that retail distributors are both canvassed and assisted by their national advertising in MACLEAN'S MAGAZINE. They recognize that $1,000—$3,000 invested in space in MACLEAN'S MAGAZINE to buy 365-day national influence is dirt cheap publicity.

THIS is but condensed presentation of MACLEAN'S MAGAZINE. Very much more can be said about its editorial policy and character, about its making, about its quest for and development of new contributors, about the policy that keeps canvassing methods and advertising columns clean, about the hearty approval of subscribers of MACLEAN'S MAGAZINE, about the significance of 50,000 circulation, about the wisdom of doing a "little advertising in a few magazines" as an initial step in national advertising plans; about the advertising of MACLEAN'S MAGAZINE in all the MacLean Publishing Company's list of business and technical newspapers, about the influence of MACLEAN'S MAGAZINE on distributors.

But time and space forbid here and now a continuation of the MACLEAN story.
What is enough to be impressed is—

MACLEAN'S MAGAZINE

Canada's National Magazine

143 University Ave., Toronto

Union Trust Bldg., WINNIPEG Boston New York Chicago London, Eng. Southam Bldg., MONTREAL

ISN'T THIS RATHER GOOD EVIDENCE THAT THE

Morse Silent Chain

IS DEPENDABLE?

THE above insert shows them operating the DIVING CONTROL in United States submarines. Could DEPENDABILITY be more essential anywhere? They also operate the STEERING APPARATUS and the PUMPING SYSTEM. Ever since the Government made comparative tests of all makes of silent chains (prior to the awarding of the contract for chains to operate the Panama Canal Emergency Gates), and discovered that MORSE SILENT CHAINS were of much higher tensile strength and much smoother running than any other make, Government specifications of all sorts are usually met only by "MORSE."

Why Don't You Profit by the Government's Experience?

MORSE CHAIN CO., Ithaca, N. Y.

Largest Manufacturers of Silent Chains in the World

BETTER THAN "GENUINE"

ATLANTIC ICE & COAL CORPORATION,
Athens, Ga.,
Dec. 19, 1916.

The Magnolia Metal Co.,
New York, N.Y.

Gentlemen:—

For your information wish to advise you I have recently used your Magnolia Metal on our large engine where I formerly used genuine babbitt, which cost just twice the price of Magnolia, and find that Magnolia is as good, if not better, and I will continue to use Magnolia babbitt as long as I can get it. I do not hesitate to recommend it to engineers, where a good metal is required.

Yours truly,
ATLANTIC ICE & COAL CORP.,
Francis Jackson, Supt.

PRACTICAL ENGINEER POCKET BOOK:
Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY
MAGNOLIA METAL CO.
OFFICE AND FACTORY:
225 St. Ambroise St. MONTREAL

A Giant for Work

An Infant for Oil

Universal Adjustment

Babbitted and Reamed Bearings

Case Hardened Steel Set Screws

That describes the Bond as well as anything we know. Constructed of the finest materials, it will outlast any hanger on the market.

Made with the famous ring oiling system, the Bond gets positive lubrication without wasting a drop of oil.

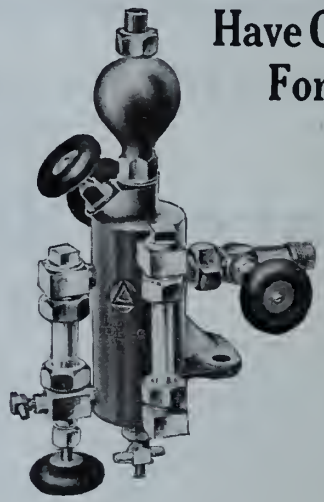
Try a Bond—that's all we ask. The result—repeat orders—are reassured.

Get that Bond Book to-day.

CANADIAN BOND HANGER & COUPLING CO.
Limited
ALEXANDRIA ONTARIO

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

ALBANY GREASE

PERFECT LUBRICATION

for every bearing in your plant may be secured with Albany Grease. Perfect not only in keeping the bearings running cool and easy, but in the elimination of friction and the reduction of wear and tear to the minimum.

ALBANY GREASE

should be used on every bearing in your plant—always. Albany Grease contains nothing harmful to bearing surfaces and can be used in any kind of grease cup. Send for a trial quantity and a cup—now.

ALBANY LUBRICATING CO.
708-10 Washington Street
New York

5F Turbine System.

Suggestions *that* Lower Costs . .

You cannot afford to overlook equipment that will reduce waste and operating expense, or increase production. Investigate the Bowser Oil Circulating and Filtering System, learn how it will prolong the life of machines, reduce coal consumption and repair bills by maintaining a steady flow of pure oil to every point of friction. Keeps oil pure and cool. No oil is lost.

BOWSER

Oil Circulating *and* Filtering Systems

2F System.

Are built for any requirement, large or small. Their durability, simplicity and accuracy, also the ease of cleaning filter sections are "Reasons Why" Bowser Systems are in use in several of the largest plants in the country.

7F Small capacity outfit.

Let us know your needs to-day.

S. F. BOWSER & CO., Inc.

Sales Offices in All Centres **Toronto, Ont.** Representatives Everywhere

"Hm! This belt's nice and pliable, George. How do you keep it that way?"
"With Cling-Suface, Uncle. I let it take up all it would hold. It's 15 years old."

"DID you wish to see me?"

The Superintendent came up and shook hands. "You're the fifth belt dressing man who's been in here this week. I'll tell you what I told the others: my belts are large enough, and are not slipping. I don't need CLING-SURFACE."

"That's fine!" said our salesman, "And how are they lasting?"

"Lasting? Great! I use an oil—put it on whenever they get dry—been using it all winter."

"Are you running any of them slack?"

"Well, not exactly. But they're not too tight, and they're big enough to carry the load—Taylor system, you know?"

"Yes. Say, did you ever look up Taylor's figures? You know he made a nine-year belt test at the Midvale Steel Company, from 1884 to 1893—three years before CLING-SURFACE was discovered. He found for one group of belts that the average cost per belt for cleaning, greasing, tightening and repairing was $12.23, of which greasing and cleaning alone was $4.24. That leaves about $8.00 per belt, or 65%, for tightening and repairing. How would it strike you, Mr. Hood, to just quit tightening belts altogether, cut out repairs, and save this 65%?"

"Do you mean—never take up a belt?"

"Not until the sides touch, yes."

"Can't be done!" the Superintendent exclaimed, "What's to prevent the slipping if it gets too loose?"

"The belt itself! Make your belts slip-PROOF. You can do it here with any belt you've got. Take this picture, for instance. Here's a 20" double-leather belt, doing 225 H.P., running over a mile a minute and operating a dynamo in an electric light plant. Almost every condition unfavorable, yet it hasn't been taken up in 11 years.

"The semi-liquid CLING-SURFACE has body, heaviness. Once in a belt it stays there, surrounds and preserves the fibres, and prevents drying out or cracking. It makes the belt mellow, pliable, elastic, and gives it weight instead of taking it away, whereas a thin oil makes your belt pliable but spongy.

"And it's a pure compound. We've sold it all over the world since 1896—and make it now so you can use it cold. It's guaranteed absolutely."

"Hm!" Mr. Hood was thinking hard—thinking about the scarcity of labor and the big Government contract the firm was going to get. "You say I won't have to take up my belts—that they'll run without slipping under full load, anywhere, and last longer?"

"Absolutely, Mr. Hood," said our salesman. "The Cling-Surface Company won't charge you a cent if you don't get these results. Shall we say 50 pounds on this understanding?

* * * * * * Thank you!

"Remember, use CLING-SURFACE and you won't need belt dressings."

Cling-Surface the life preserver for belts TRADE MARK

Cling-Surface Co

1057 Niagara Street
Buffalo New York
U S A

If any advertisement interests you, tear it out now and place with letters to be answered.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

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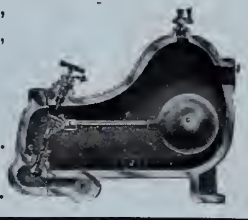

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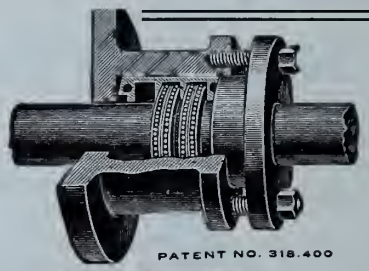

PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,388	" "	895,791
" "	774,490	" "	896,066
" "	775,193	" "	905,103
" "	775,194	" "	934,829
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BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

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All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
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(b) To hold meetings for discussing theoretical and practical matters pertaining to its calling;

(c) To examine stationary engineers and firemen as to their proficiency, and to grant graded certificates of ability to its members, and to be a medium through which steam and electric users may be supplied with good and reliable engineers, and to grant relief to its members in cases of sickness and distress."

By joining one of the subordinate associations of the C.A.S.E. you will be greatly benefited. For full particulars write

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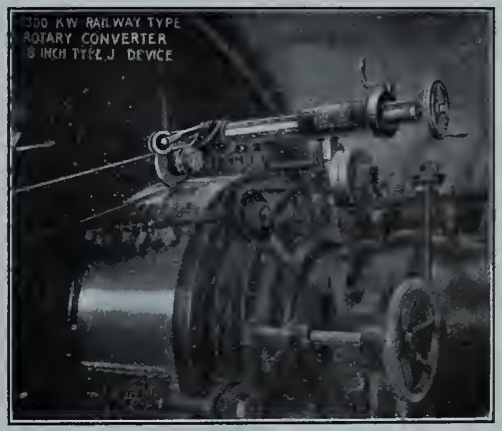

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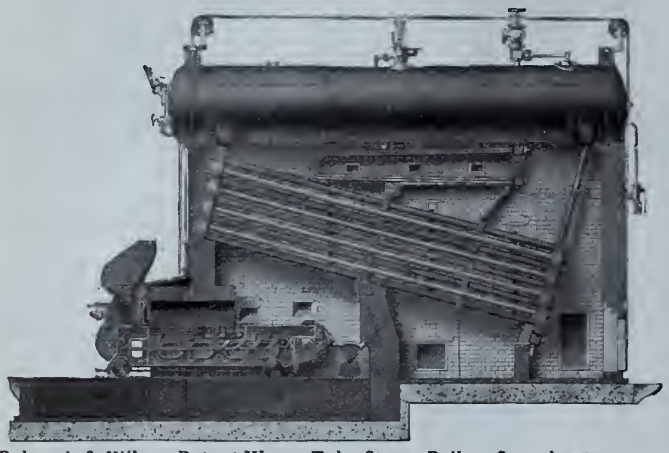

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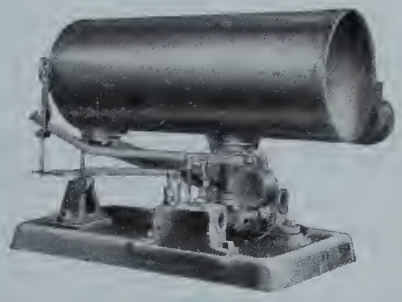

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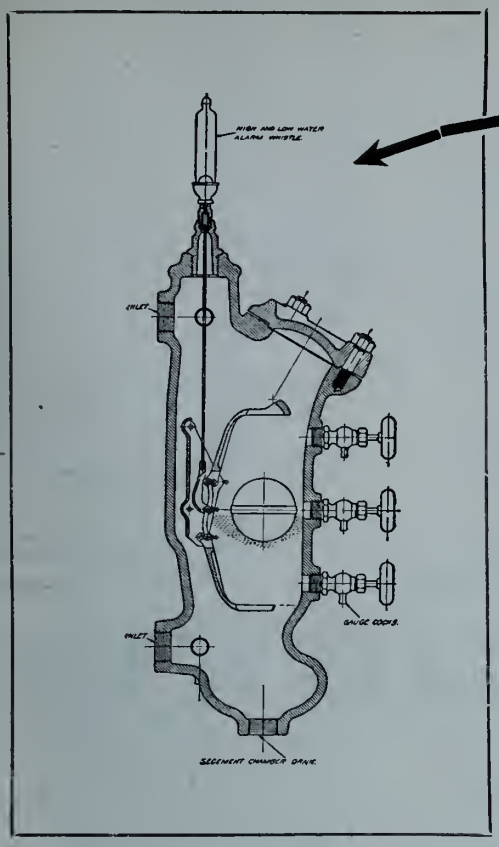

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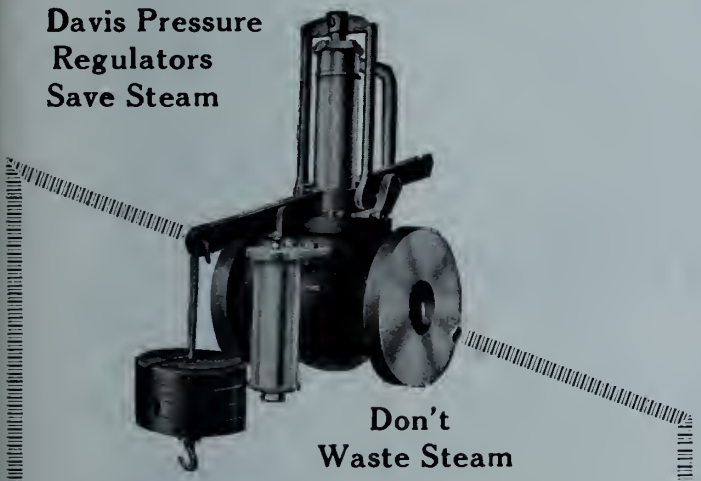

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You carry high boiler pressure for emergencies and peak loads, but are you sure this reserve is not slipping away? You know only too well the cost of coal —conserve it by keeping your steam pressure under full control with

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Put these automatic valves to work wherever you can use less than boiler pressure. The cost is trifling and the saving big. Forty years on the market is enough to prove they are built right. Send for catalog. It will show you a way to cut costs.

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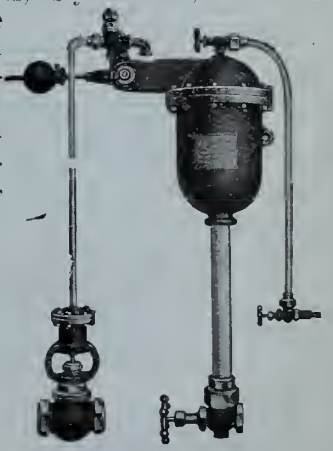
The Vigilant Feed Water Regulator effects a saving in coal ranging from 3 to 17 per cent. This is a proven fact worthy of your attention in this period of increasing coal prices.

Boiler feed regulation is, as you know, a source of constant trouble and anxiety. You can overcome these difficulties entirely with the "Vigilant." On guard day and night.



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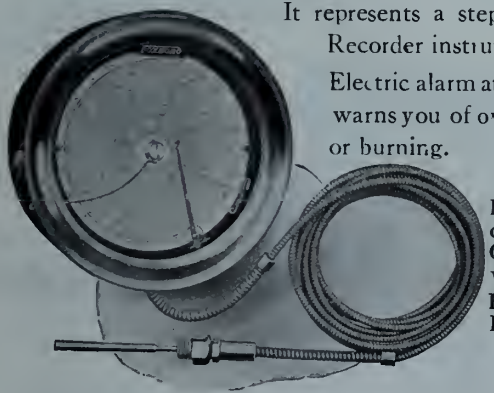

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Manufactured by THE FOXBORO CO., Inc.
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Temperature Instruments

Indicating Recording Controlling

Their construction, their never failing accuracy, is due to the careful application of our many years experience in producing *only* the most perfect instruments for the work they must perform. No detail is to small to receive complete consideration. Results obtained from the service they give under the most adverse conditions, continually guide us in the perfection of our product.

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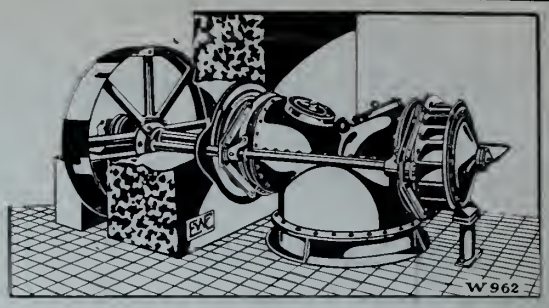

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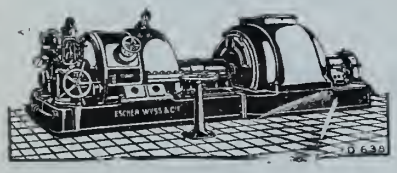

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62-17

INDEX TO ADVERTISERS

A

	PAGE
Albany Lubricating Co.	75
Alberger Heater Co.	68
American Steam Gauge & Valve Mfg. Co.	66
American Steam Pump Co.	54
Anderson Co., V. D.	83
Armstrong Cork Insulation Co.	11
A.S.K. Chemical Co.	51

B

Babbitt Steam Specialty Co.	62
Babcock & Wilcox	78
Bawden Machine Co., Ltd.	6
Bennis & Co., Ltd., Ed.	4
Beveridge Paper Co.	86
Boiler Inspection Dept.	77
Boving Hydraulic & Eng. Co.	76
Bowser, S. F., & Co., Inc.	75

C

Can. Assoc. Stationary Engrs.	77
Can. Bond Hanger & Coupling Co.	74
Can. Detroit Lub. Co.	74
Can. Economic Lubricant Co.	5
Can. Fairbanks-Morse Co.	53
Can. Laco-Philips Co.	85
Can. H. W. Johns-Manville Co., Ltd.	9
Can. Morehead Mfg. Co.	81
Can. Sirocco Co.	81
Can. S K F Co.	69
Canuck Supply Co., Ltd.	61
Chaplin-Fulton Co.	83
Cling-Surface Co.	75
Coe Co., C. T.	54
Cole, Geo. W.	50
Coppus Eng. & Equip. Co.	6

D

Darling Bros.	11
Dart Union Co.	55
Davis Regulator Co.	83
Dearborn Chemical Co.	13
D'Este Co., Julian	58
Direct Separator Co.	70
Dixon Crucible Co., Jos.	50
Dominion Belting Co.	62
Dominion Coal Co.	76
Durabla Mfg. Co.	66

E

Economy Fuse & Mfg. Co. of Canada	4
Escher Wyss & Co.	88

F

Federal Engineering Co.	81
Foxboro Co.	87
Francis, Walter J., & Co.	52
Frick Co.	56

G

Galt Foundry Co.	5
Garlock Packing Co.	60
Garth Co.	76
Gates, John W.	52
Goldie & McCulloch Co.	18
Goodyear Tire & Rubber Co.	64
Graton & Knight Mfg. Co.	71
Greene, Tweed & Co.	67

H

Holmes Metallic Packing Co.	76
Homestead Valve Mfg. Co.	58
Hoyt Metal Co.	2

I

Inglis Co., John.	Inside back cover

J

Jamison Cold Storage Door Co.	12
Jefferson Union Co.	57
Jenckes Machine Co.	4
Jenkins Bros.	15
Jones Underfeed Stoker Co., Ltd.	2
Jordan Bros., Inc.	77

K

Kellogg & Co., E. H.	52
Kerr Engine Co.	58

L

Ladd Co., The Geo. T.	76
Laurie & Lamb	14
Leitch Co., The Arthur S.	49
Liberty Mfg. Co.	47
Linde Canadian Refrigeration Works Co.	10
Long, J. T.	51
Lunkenheimer Co.	59

M

MacGovern & Co.	87
MacKinnon, Holmes & Co.	52
MacLean's Magazine	72
Magnolia Metal Co.	74
Martell Packings Co.	66
Mason Regulator Co.	6
Mason Regulator & Eng. Co., Ltd.	7
McAvity & Sons, T.	59
McDougall Caledonian Iron Works Co.	16
McGhie, W. C.	76
McLaren, D. K., Ltd.	63
Merchants Rubber Fdy.	51
Morris Machine Works	54
Morrison Brass Mfg. Co., Jas.	Outside back cover
Morse Chain Co.	73
Murphy Iron Works	3

N

National Boiler Seam Protector Co.	8

O

Oliver Chilled Plow Works	51

P

Peacock Brothers	87
Peerless Rubber Co.	Inside front cover
Penberthy Injector Co., Ltd.	Outside front cover
Pennsylvania Flexible Metallic Tubing Co.	70
Pratt & Cady Co.	68

S

Sarco Co., Inc.	52
Scaife, Wm. B., & Sons Co.	86
Schaeffer & Budenberg Mfg. Co.	6
Shell-Bar, Boico Supply, Ltd.	3
Smart-Turner Mach. Co.	77
Starrett, L. S., Co.	49
Steel Mill Packing Co.	62
Storey Pump & Equipment Co.	54
Sturtevant Co. of Canada, B. F.	49

T

Taylor Instrument Co.	87
Thomas Grate Bar Co.	5
Trimont Manufacturing Co.	78
Toch Bros.	53

U

Uehling Instrument Co.	81

V

Vilter Mfg. Co.	10

W

Wall, W. J.	51
Waterous Engine Works Co.	1
Watson & McDaniel Co.	76
Williams & Co., J. H.	78

Y

York Mfg. Co.	12

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There's an Inglis Boiler for Every Purpose

Built to Give Long and Economical Service

Inglis Boilers are made to stand the severest tests and give the best of all-round service.

Best of material, best of workmanship, and best of experience are behind their construction. They easily pass all government tests. For efficient and economical boiler room service in your power house, have the "Inglis" equipment installed. Satisfaction guaranteed.

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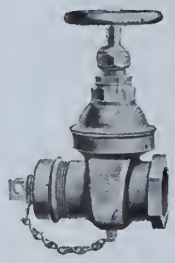

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With Hose Cap.

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Renewable Disc

Factory Tested Steam Goods

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Genuine
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Straightway
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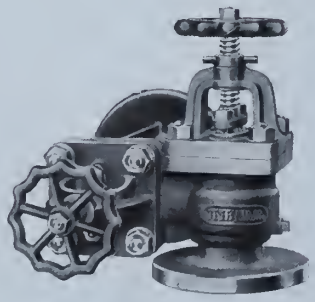

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Combined Stop and Check Valve

Pressure Gauges and Recording
Instruments

J.M.T. Reducing Valve
Will not Equalize

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A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

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MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1207 Union Trust Bldg.

Vol. X—No. 11 Publication Office, Toronto—November, 1917 Published Monthly $1.00 per Year.

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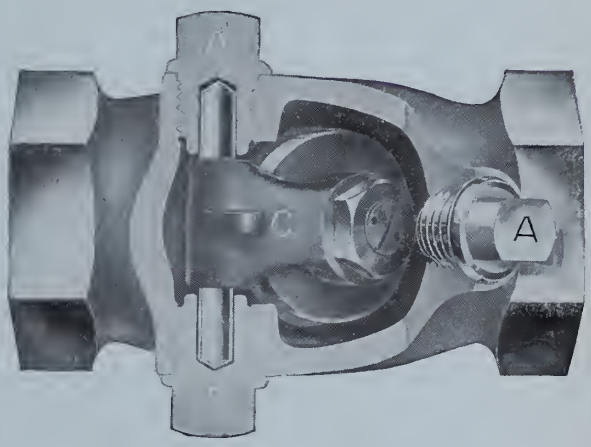
TRADE PENBERTHY MARK

SWING CHECK VALVES

Regrinding Type

EXTERNAL VIEW

Registered For 200 Lbs. Steam Pressure



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THAT WILL SOLVE YOUR CHECK VALVE TROUBLES

"BUILT FOR SERVICE"

Note the correct angle at which the disc rests when closed. Prevents opening of same from pressure of condensed water in pipe, or from pipe line getting out of true. The body of the valve proper is not subject to wear from action of disc, as the hinge pin "C" bears on the two end plugs "A", and these parts can be renewed at very little cost. In some makes of valves the hinge "C" rides in a groove of the body proper and in case wear throws the disc out of line, the whole valve has to be replaced.

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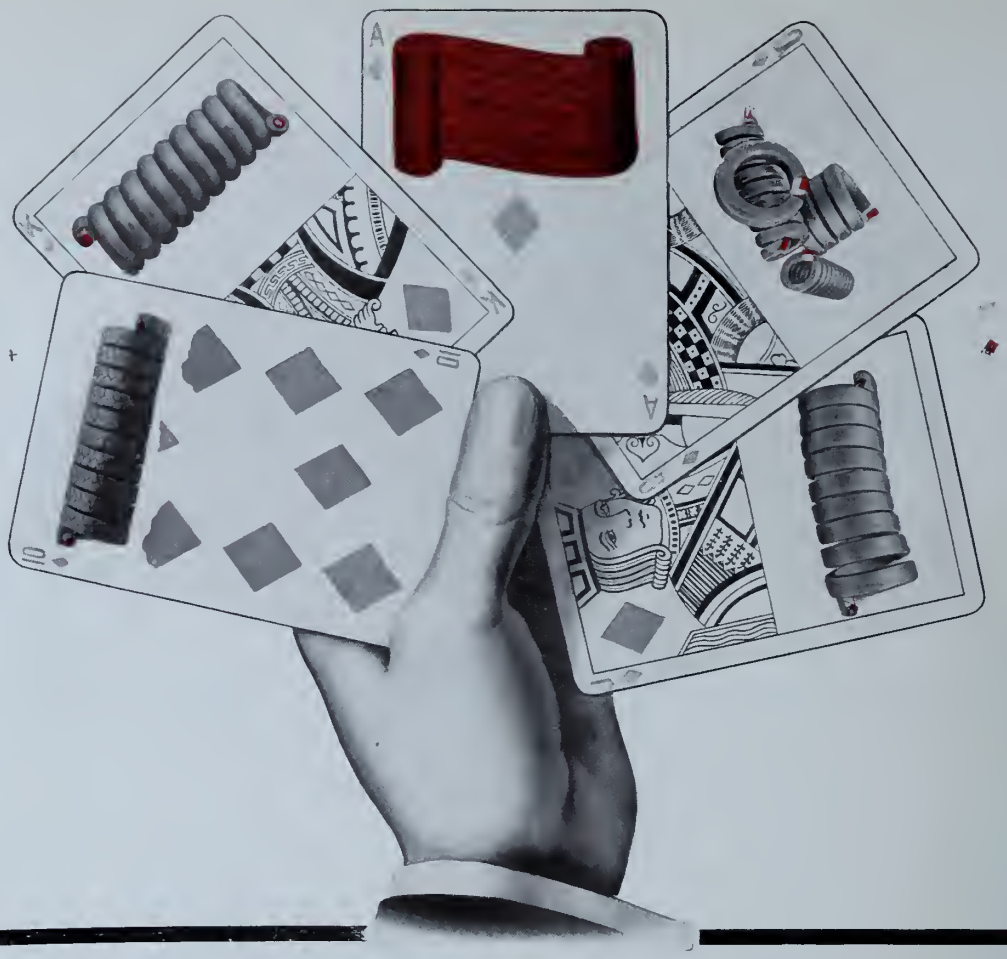

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That Calls the Bluff on Imitations

Every Peerless Packing is built up to a standard, not down to a price. They give service.

In these times when power plants are being forced to their limit it is policy to use the best packing you can buy, it means saving of power and time.

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CANADIAN ASBESTOS COMPANY

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BOILERS

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14 Jones Underfeed Stokers

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In a Little Over Two Months

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CHEAPER COAL and NO CLINKERS

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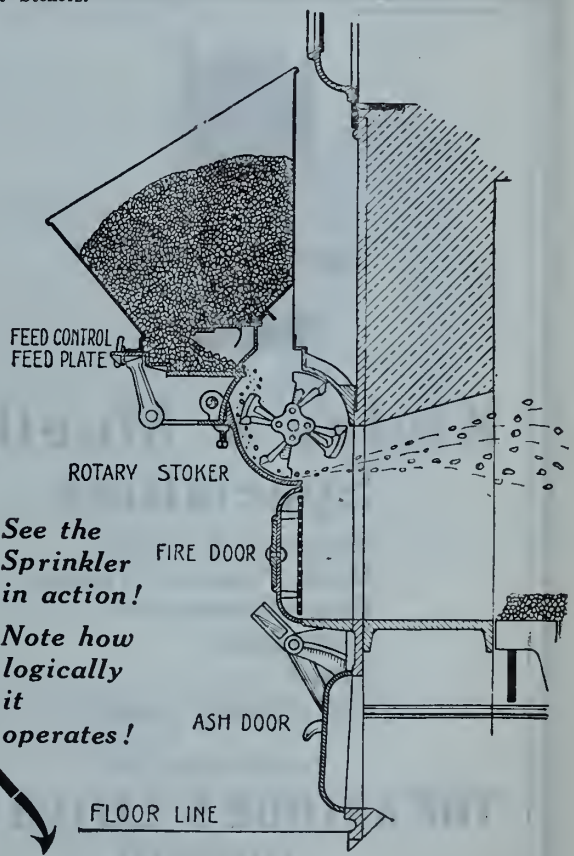
That the highest boiler efficiency on every test was always obtained with a level fire 3 to 4 inches thick, combined with frequent and light charges of fuel to the furnace, and the nearer the supply of coal approached a continuous feed the better were the results.



The Galt Sprinkler Stoker automatically feeds and uniformly spreads the fuel to the furnace in a light continuous stream and gives a perfectly level fire, 3 to 4 inches thick.

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500,000 H.P.

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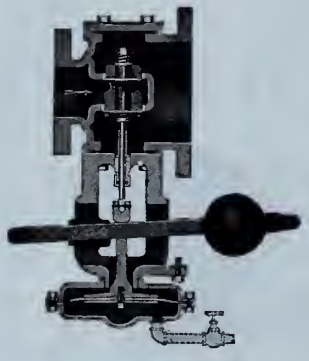

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THE ARTHUR S. LEITCH CO.

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Third, the thermometer must be suitably constructed for the intended application.

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Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Guages, Guage Testers, Tachometers, Steam Calorimeters, Counters, etc.

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Mason Standard Bronze Reducing Valve

Mason Reducing Valves (Genuine),
Mason Pump Governors,
Mason Pressure Controllers.

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Coppus Turbine-driven Blowers,
Sims Hot Water Generators.

Sims Storage Heaters,
Sims Open Feed Water Heaters.

Bundy Oil Separators,
Ashton Gauges and Safety Valves.

Federal Metallic Packing,
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Bawden Pumps (Reciprocating & Centrifugal)
Stratton Steam Separators.

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Reilly Evaporators and Distillers,
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New Bundy Return Trap

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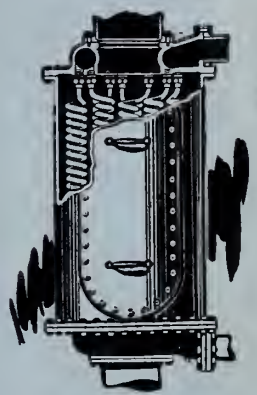
our Sales Engineers know the *practical application* of our lines to *actual conditions,* and sell from *knowledge,* not from *catalogs.* We furnish *results,* not merely *machinery.*



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Bulletins and full information gladly furnished.

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in a smooth-running plant, in saving time, trouble, worry and money, are particular about details of equipment

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GOODYEAR STEAM HOSE

is Trouble-Proof, Lasting, Economical

Goodyear Steam Hose is hose you will find good to handle. Its outer cover of rubber is made to adhere firmly. It will neither blister nor crack.

And mark this! Many tests and experiments have Goodyear chemists made to produce an inner rubber tube that would defy the action of steam.

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The plies in Goodyear Steam Hose are built of strong duck. They are embedded in a grade of rubber that remains active, keeps the hose flexible, welds the fabric together.

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It will help you to know the service extended by Goodyear in solving hose problems. There's a Goodyear representative located in your territory. His experience and advice may help you.

The Goodyear Tire & Rubber Co. of Canada, Limited

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Power Plant Service

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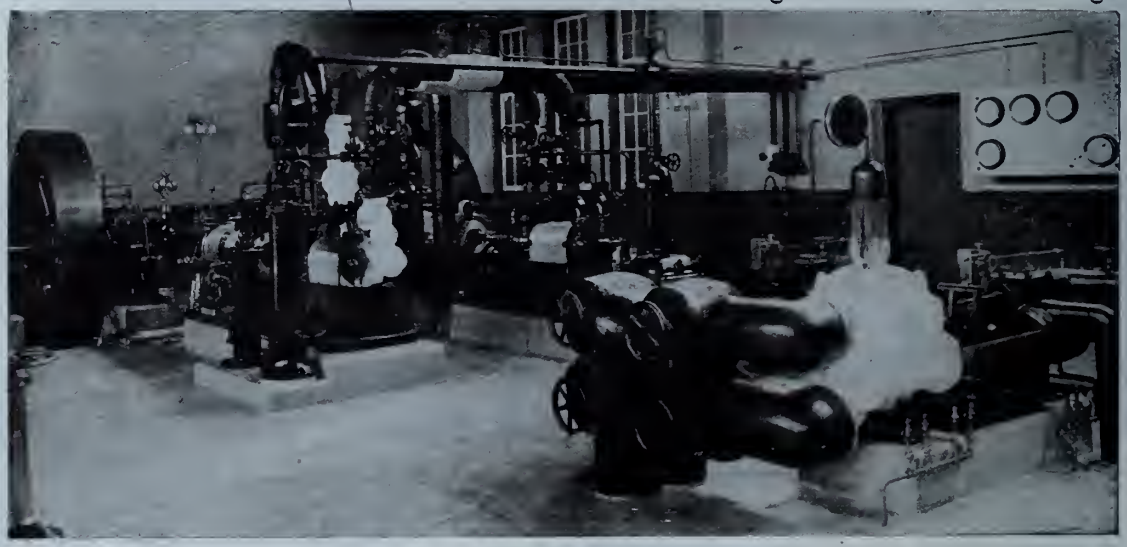
The Canadian H. W. Johns-Manville Co., Inc.
MONTREAL TORONTO VANCOUVER WINNIPEG

View above: Nashville Railway & Light Co., Nashville, Tenn. High Temperature Cement used.

"THE LINDE"

REFRIGERATING AND ICE MAKING MACHINERY

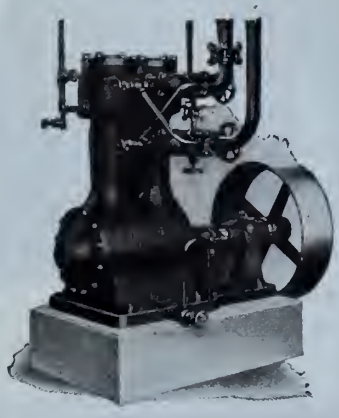
MADE IN CANADA SINCE 1896



THE LINDE CANADIAN REFRIGERATION CO., LTD.

MONTREAL, 37 ST. PETER STREET

TORONTO, WINNIPEG, CALGARY AND VANCOUVER



Ice-making and Refrigerating Machinery

Built in any capacity that you desire. HORIZONTAL OR VERTICAL

Our SMALL MACHINES have the same "regularity of Operation," "Reliability" and "Efficiency" as our large ones. AMMONIA FITTINGS, CONDENSERS, BRINE COOLERS, ETC.

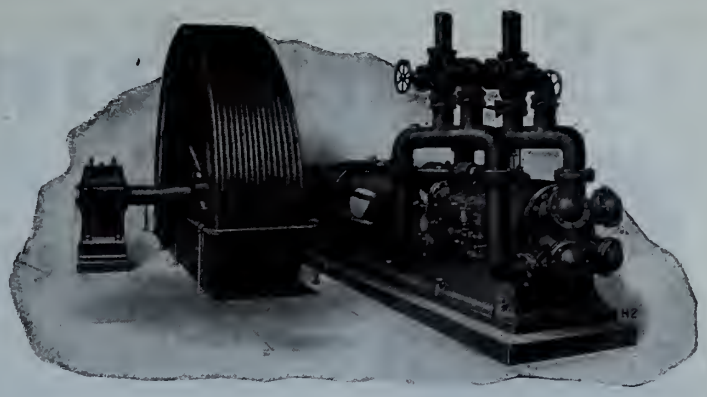
Our Machines are in daily operation in Canada.

CORLISS and POPPET VALVE ENGINES.

The Vilter Manufacturing Company

242 Beecher St. - - - Milwaukee, Wisconsin

PERFORMANCE COUNTS



FRICK EQUIPMENT is your guarantee for continued performance with an assurance of maximum economy and minimum upkeep cost.

Many of our machines have been in constant operation for over a quarter century, producing the same capacity, and more in some cases, than their guarantee at the time they were installed. May we give you the names of the owners of these machines?

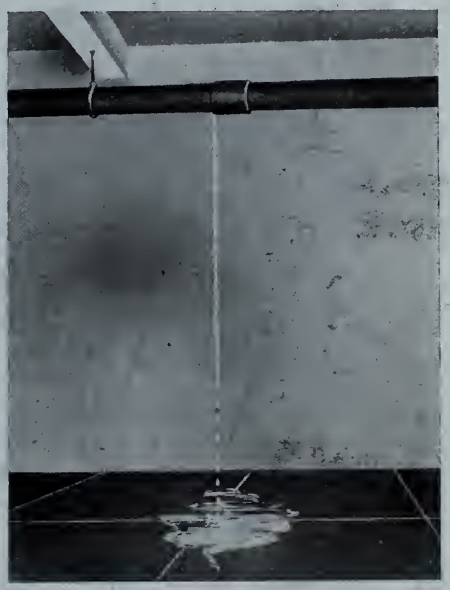
Let us give you the advantage of our 35 years' experience in all lines of refrigeration without obligation to you.

Write us before buying your next plant or making alterations to your present one.

Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1882

Canadian Representatives:
FRICK ICE & REFRIGERATING COMPANY, Montreal, Canada

You Would Not Allow This In Your Plant



If a brine line should develop a leaky joint, wouldn't you have it repaired as soon as possible? You would not let a loss like that continue very long. But how about the unseen loss of refrigeration from the brine and ammonia lines, coolers, tanks, etc.? Have you reduced it to the minimum, by insulating them with the proper thickness of

Nonpareil Cork Covering

For All Cold Pipes and Tanks

You cannot see it, of course, but a surprisingly large amount of refrigeration is lost from bare, cold pipes. For instance, 93 feet of 4-inch pipe, carrying brine at 15° F. with the surrounding air of 75° F. would lose one ton of refrigeration every twenty-four hours. The same would also be true for 120 feet of 3-inch, or 176 feet of 2-inch line. Even at the low cost of 50c per ton for refrigeration, this loss would amount to $180.00 per year. If, on the other hand, the lines were insulated with the proper thickness of Nonpareil Cork Covering, at least 80 per cent. could be eliminated—reduction of $144.00 per year.

Would it not be a good plan to check up the amount of bare cold piping in your plant, and then let us tell you how much refrigeration Nonpareil Cork Covering would save?

Full information upon request

Armstrong Cork & Insulation Company, Ltd. 504 McGill Building MONTREAL, QUE.

Also makers of Nonpareil Corkboard Insulation for cold storage rooms; Nonpareil High-Pressure Covering for steam lines; Circle A Cork Brick for cold storage room floors; Nonpareil Cork Machinery Isolation for noisy machinery; and Linotile for floors in offices, residences, etc.

BUY VICTORY BONDS—SAFEST INVESTMENT IN CANADA TO-DAY.

Something New

In the 4th Edition of our Fitting Catalog, recently issued, we illustrate a line of SCREW AND FLANGED AMMONIA FITTINGS, supplementing the large line of Standard YORK Valves and Fittings which are coming into more general use each year.

This is in line with our policy to design and place on the market Fittings and Apparatus that will make the application of MECHANICAL REFRIGERATION more convenient and economical.

From the number of orders received, it is quite evident that these SCREW AND FLANGED FITTINGS have met with the endorsement of the practical Engineer.

By their use YOU can—

SAVE WEIGHT WITHOUT LOSS OF STRENGTH OR CONVENIENCE.

ELIMINATE *ONE-HALF* THE *GASKET* JOINTS.

DO MORE RAPID PIPE FITTING, by ELIMINATING *ONE-FOURTH* OF *ALL JOINTS.*

as compared with full flanged fittings.

York Manufacturing Co.

(Ice Making and Refrigerating Machinery Exclusively)

YORK, PA.

Represented in the Dominion by **CANADIAN ICE MACHINE COMPANY**

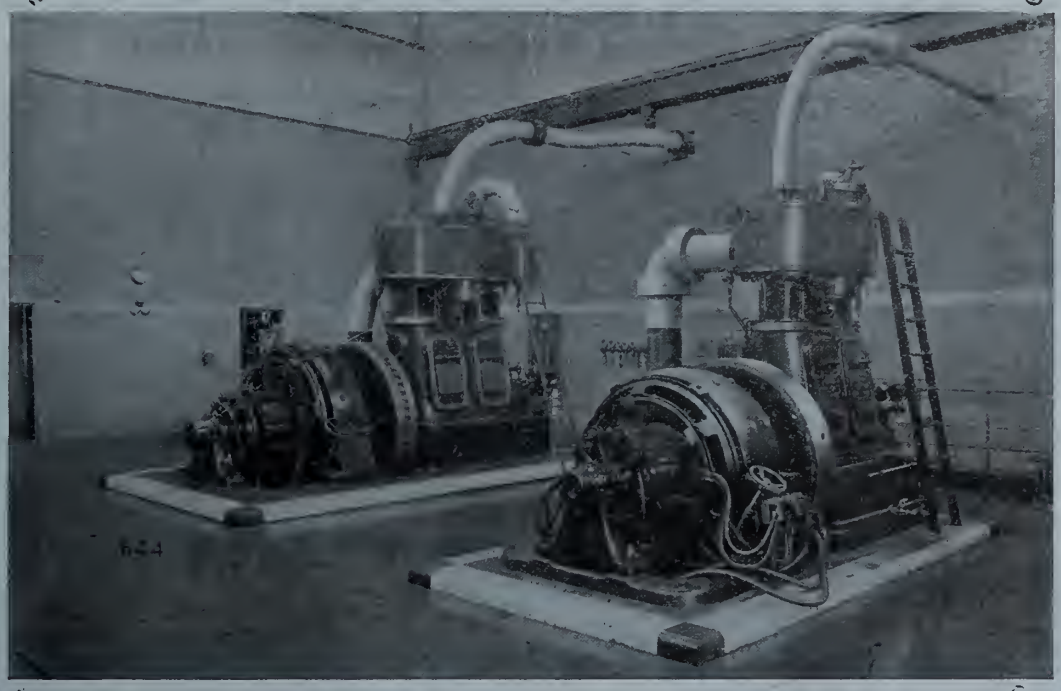
MONTREAL, 626 Coristine Bldg. TORONTO, 82 Chestnut St. WINNIPEG, 85 Lombard St

UNCLE SAM uses them. CANADA uses them. The biggest packers and storage houses use them. BECAUSE THEY SAVE DOLLARS. "JONES" AND "NOEQUAL" Cold Storage and Freezer Doors (standard or fireproof) are rendering a National service because they shut out losses caused by poor, inefficient doors. May we have the pleasure of sending "The Economy of Patented Cold Storage Doors" which describes the SERVICE fully?

Jamison Cold Storage Door Co.

Formerly Jones Cold Storage Door Co. HAGERSTOWN, MD., U.S.A.

BELLISS & MORCOM, LTD.
Engines and Air Compressors



Belliss & Morcom Engines installed in McGill University Power House
Total Horse Power, 1010 B.H.P.

We have for immediate delivery several Engine Generator Sets. Write for Particulars.

Send Us Your Enquiries For

Steam Engines	Condensing Plant	Hydraulic Pumps
Gas Engines	Centrifugal Pumps	Hydraulic Accumulators
Oil Engines	Boiler Feed Pumps	Pressure Filters
Diesel Engines	Water Wheels	Gravity Filters
Steam Turbines	Water Meters	Water Softening Plants
Air Compressors	Hydraulic Presses	Refuse Destructors

Activated Sludge Sewage Disposal Plants

Complete Power Plants Designed and Erected.

LAURIE & LAMB

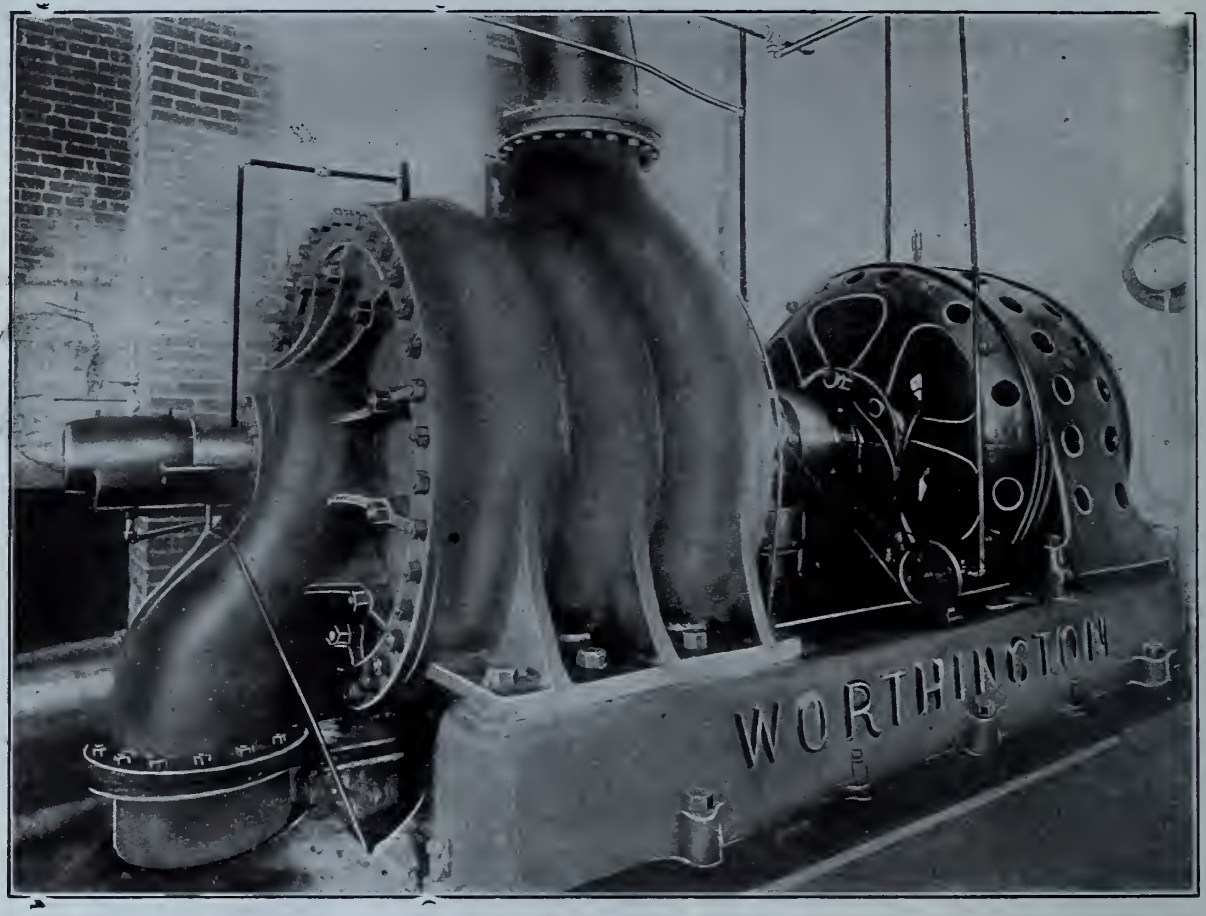
Engineers

211 Board of Trade Bldg. :-: :-: MONTREAL

THE JOHN McDOUGALL CALEDONIAN IRON WORKS CO., Limited

Manufacturers of Boilers, Castings, Condensers, Elevators, Engines, Filters, Forgings, Hydraulic Machinery, Pumps — centrifugal and reciprocating, Steam Turbines, Tanks, Water Wheels, Water Works Plants

Works: Seigneurs and William Streets, MONTREAL



5,000,000 gallons daily—Montreal Water Works—Driven by 400 H.P. Induction Motor.

Our Engineers have spent many years developing Centrifugal Pumps and we are now able to offer you perfected designs in any size pump from inch and a half and up for any service you may desire, and to be driven either with motor, engine or belt.

Write us for Engineering information, or prices, any time.

Sole Canadian Agents for H. R. Worthington Co.

Keeping in Stock at Montreal a large assortment of their Boiler, Feed and General Service Pumps

The Publisher's Page

TORONTO November, 1917

The Economy of Business Paper Advertising

By H. E. CLELAND, NEW YORK

Awarded the Higham prize at the convention of Associated Advertising Clubs, at St. Louis, June, 1917. This prize is given annually to the one delivering the most constructive address in the fewest words.

ECONOMY is a many sided question and may mean anything up to the threshold of total abstinence. But Webster tagged it best when he said it means "a judicious expenditure of money."

War is shoving economy of this kind into the spotlight, thereby proving that war is not all battles, blood and what Sherman said it was. War has its good side. It has upset a centuries-old and centuries-rotten despotism. It has whipped British manufacturing methods into a state of high efficiency. It has waked up a snoring America.

In these conditions there's room for the advertising man, whether he be publisher, agent, salesman or user, who persists in dressing advertising in garments of glittering guff. It must be stripped to its effective self; made ready to fight, not to pose.

In brief, advertising must now line up with every other business and make every dollar spent for it a "judicious expenditure of money."

The business press of the country welcomes this return to the fundamentals, for with this attitude must come a full appreciation of the effective economy of business paper advertising.

Business paper advertising has never posed. It never has been nor will be surrounded by the pomp and circumstance of enormous circulation. It cannot hope to fly the banner of tremendous rates. The average cost per page is so low that it doesn't sound respectable.

In short, business paper advertising is not the bass drum of this band. It doesn't make the noise—but it carries the tune, clear and true.

We assert for it a very high efficiency per dollar of cost. And that, we believe, is the aim—and rightfully the aim—of every straight-thinking advertising man.

THE REASONS WHY

And these are the reasons why it is effective.

First, the editorial character of each paper limits the circulation to those men in an industry or trade who are responsible for results. These are the men who actually buy or recommend the buying of the machinery or merchandise advertised in the paper. Therefore, waste circulation practically does not exist and is in every event cut to the bone. Hence, at the very beginning we strike at effective advertising's greatest extravagance, waste circulation, and put in its place intensive circulation.

Second, the buying power per subscriber represents an infinitely greater sum than the buying power per subscriber of any other class of publication because each buyer purchases for business and not private consumption.

Third, the editorial contents of the paper are in harmony with the advertising pages. The first tells a man "how" and the second shows "what with." To borrow the simile of a colleague of mine, the whole paper may be regarded as an enormous advertisement with the editorial pages carrying the educational copy and the advertising pages representing the return coupon.

In a recent investigation as to the effectiveness of advertising run next to reading matter and advertising which was segregated, it was demonstrated that when the reading matter next to the advertisement was germane to the product advertised, then results from the advertising were far and away ahead of results when the reading matter was on a subject foreign to the product advertised.

This investigation was carried on in the general field, but I regard it as one of the best arguments for business paper advertising I have ever heard. In a sense, all advertising in a business paper is "next to reading."

Those three fundamental reasons form the backbone of effective economy in advertising and sum up thus:—

THE CONCLUSIONS

Business paper advertising is economical because it reaches—and the advertiser only pays for—a circulation of tremendous buying power which is continually being taught by the publication itself to want the products advertised.

The business of the busines papers is to exert a wise and wide influence upon the commercial and industrial development of the country.

We cannot surround them with flowers and furbelows, nor is it necessary to allure the non-technical, non-trade man with pictures of Gertie Coughdrop, "the film's flossiest flapper."

Our readers are not to be caught by any cheap expedients. And those editors and advertising writers who find it necessary to mount their untamed vocabularies, jab them a couple of times with their favorite adjectives, and ride off in a ribald revel of words, have no place in the modern business publication.

Business papers are not intended to amuse, are not intended for the tired business men. They touch men—and men only—on that side of their lives which occupies most of their wakeful hours. They instruct, lead, guide and help men to do things, to build things and to sell things. They are for the world's doers when they are in the midst of doing.

In one of Mark Sullivan's editorials in Collier's he says:—

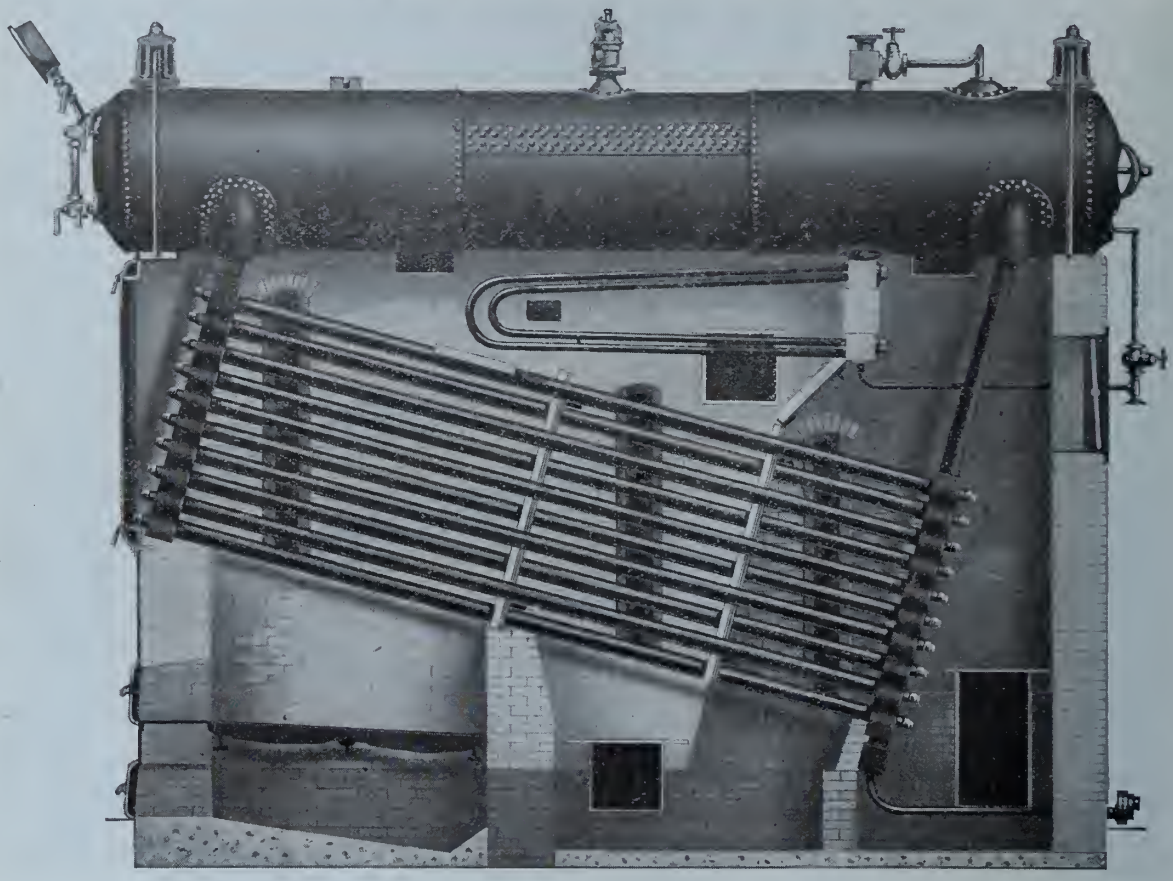
"Progress is no monopoly of the cannon makers. In one issue of the 'Electrical World' we note that the Columbus (Ohio) Railway, Power & Light Company has set out to make its buildings safer. Fire escapes, standard doors, and other improvements have been added, along with a rigid system of inspection to prevent the accumulation of waste and grease, so that in three years fire risks and insurance rates have been cut nearly in half. In Johnston, S.C., F. M. Boyd, manager for the Carolina Public Service Company, has devised a new type of twenty-five foot pole with a twelve-foot mast-arm sticking out on the street side so as to keep the poles lined up on the curb, but get the wires away from the beautiful old elms and water oaks that are the glory of Johnston's highways. Anyone who has seen the ruin and multilation left by fanatical tree trimmers will appreciate Mr. Boyd's device. The Ohio Electric Light Association reports that its members have saved from three to five cents per ton on all coal handled at certain of their power houses by putting in an eight-hour day for firemen. This ought to interest the old-timers who think twelve hours' toil an inalienable right for engine-room workers. Those three items cover vital subjects and are only part of the grist in one issue of a live technical journal. That's how our United States goes along."

Those of you who know Collier's know that this comment is from an authority whose point of observation is a long way from the bull pen.

(Continued next month.)

G. & McC. CO.

BOILERS



Sectional View, Standard Type "B," Sectional Water Tube Boiler, with Superheater.

G. & McC. Water Tube Boilers are fitted with large Steam and Water Drums, connecting nipples of increased size and straight 4" tubes, all of which insure

POSITIVE AND RAPID CIRCULATION, and INCREASED STEAMING CAPACITY

All parts subjected to steam pressure are made of FORGED STEEL

G. & McC. Engines and Boilers are giving satisfaction in thousands of Canada's leading industrial institutions. Write us for prices, plans, specifications, etc.

The GOLDIE & McCULLOCH CO., Limited

Head Office and Works: GALT, Ontario, Canada

TORONTO OFFICE: Suite 1101-2, Traders Bank Bldg.

WESTERN BRANCH: 248 McDermott Ave., Winnipeg, Man.

BRITISH COLUMBIA AGENTS: Robt. Hamilton & Co., Vancouver, B.C.

QUEBEC AGENTS: Ross & Greig, 412 St. James St. Montreal, Que.

The C.P.R. Quebec Terminal Power House Equipment

Staff Article

While much of the pleasure and comfort of modern railroad traveling is due to the high standard of excellence attained in the construction and furnishing of rolling stock, the initial facilities accorded the traveler by insuring a proper start, have much to do with the degree of satisfaction resulting. Just how much mechanical equipment contributes to this end is set forth in the following article describing terminal power house equipment.

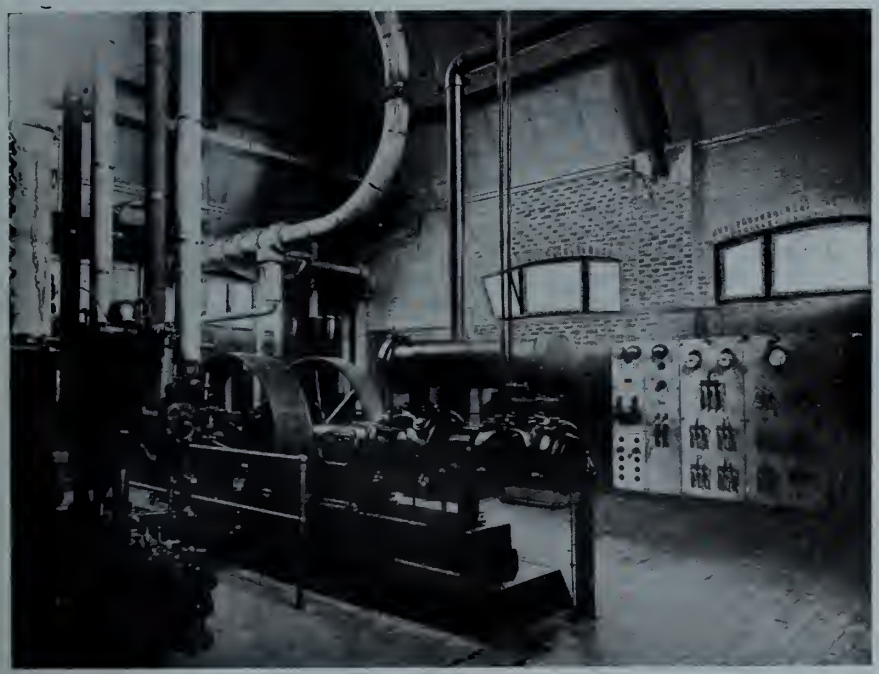
WHILE it is true that perfection is practically unattainable in any enterprise or industry, it must be admitted that a very high state of efficiency has been achieved in many lines of activity. In this respect it will be readily recognized that railroad travelling has become one of the greatest pleasures in which man can indulge. After a journey of many hours one can leave the train almost as fresh as when he entered it. Many things combine to make this result possible; proper ventilation the year round; ample heating in cold weather; upholstering that is thoroughly cleaned at all main terminals; modern toilet and dining accommodation; all these and others unite to improve the sanitary conditions that a few years ago were not among the advantages enjoyed at the present time. In keeping with the spirit of the times the Canadian Pacific Railway has always endeavored to anticipate the desires of the travelling public, and the latter have generously shown their appreciation of the company's efforts.

The recently completed power house in connection with the new station at Quebec exemplifies the modern nature of the facilities that are installed throughout the system for maintaining the high standard of efficiency that is so marked in every branch of the service. The building, which is designed on the French style of architecture, is constructed of bault limestone and citadel brick, with steep sloping, copper-covered roof. The building is almost square in shape, the dimensions being 48 by 66 feet, with the boiler room occupying about one-half the entire space.

AIR COMPRESSORS, FEED-WATER HEATERS AND HEATING SYSTEM GAUGES.

Boiler Capacity

Two twin Babcock & Wilcox, 150 horse-power boilers, equipped with superheaters, are installed; each set is provided with a separate header, that delivers steam through a 6-in. pipe to the 8-in. main, the 6-in. connection being fitted with a non-return valve and a gate valve. The steam required for the operation of the various engine room units is taken from the 8-in. main located about 20 feet from the floor. The boilers are equipped with Jones underfeed stokers, and the air for the combustion is supplied by a 5-ft. Sirocco blower, that is operated by a 6 x 6 in. vertical steam engine. Coal is delivered from the cars alongside the boiler room into bunkers adjacent to the firing end of the boiler.



GENERAL VIEW OF ENGINE ROOM.

The feed water pumps are of the Weir 12 x 6 in. duplex type and are located just to the left of the engine room entrance. These pumps take the water from the Cochran heater, into which all returns from the station and freight shed heating system are discharged, together with the exhaust from the engines and pumps; all water is metered as it passes through the heater. Both the 6-in. and 4-in. steam mains to the freight shed heating system and the 3-in. return have a total length of about 625 ft. The pressure required for heating the station is about 2 lbs., while that for the sheds is about 3 lbs. per sq. in. It might be mentioned that all eaves are equipped with steam jets to prevent freezing in cold weather. All reducing valves throughout are of Mason type. The station ends of all tracks are fitted with steam connections from the boilers for keeping stationary coaches properly heated during cold weather.

Compressor and Battery Plant

Facilities for the effective testing of air brakes on detached coaches is an important requirement in railroad ter-

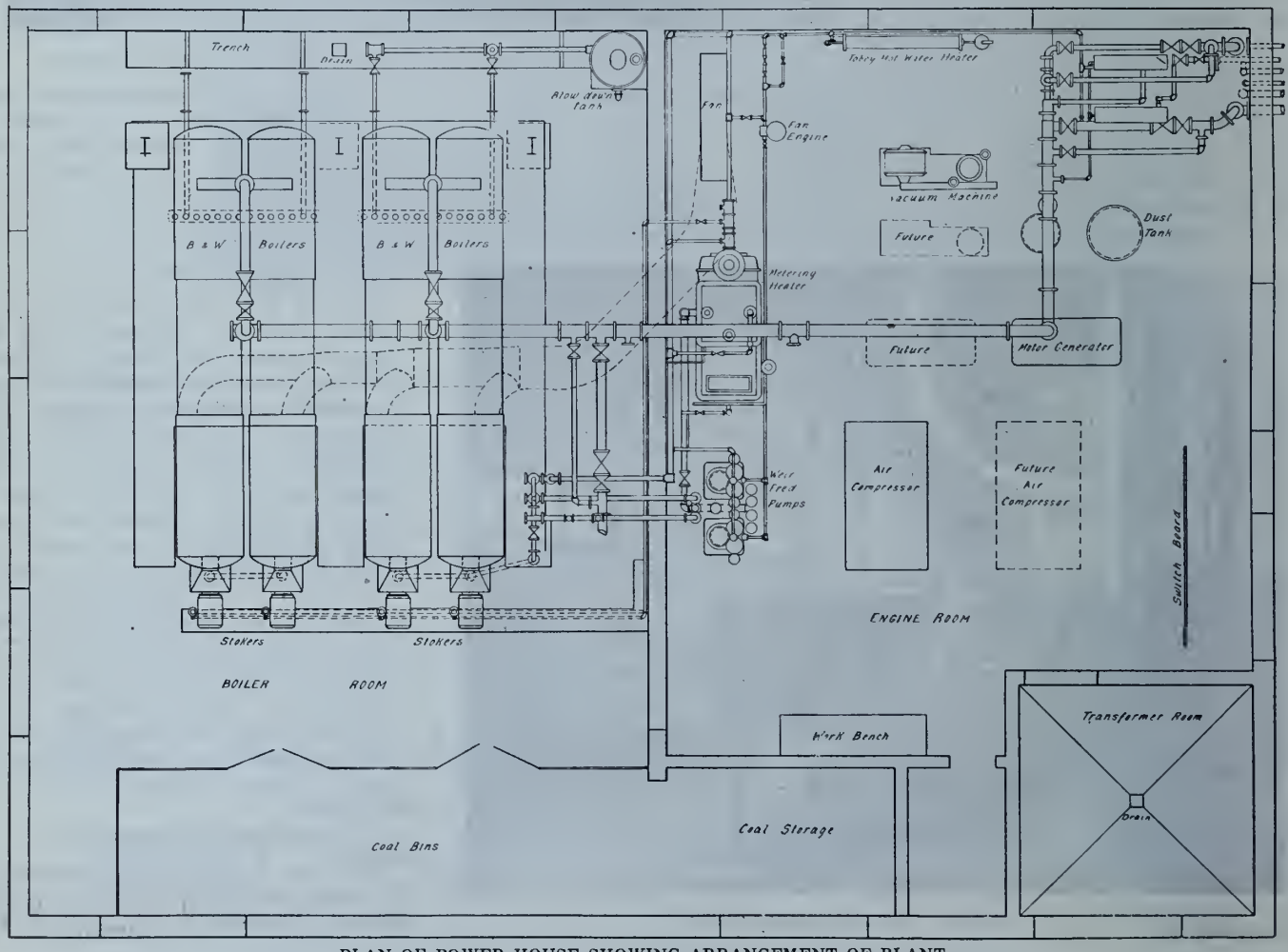
minals. For this purpose there is installed an Ingersoll-Rand 500 cu. ft. air compressor; this unit is belt-driven by a 75 h.p. Canadian General Electric motor. The compressor is fitted with an overload valve that closes the discharge when the desired pressure in the reservoir has been attained, permitting the machine to run light until the pressure again falls below a certain point. A special panel is located to the left of the main switchboard and is equipped with an automatically-controlled set of four magnets for regulating the speed of the motor when taking up the load; this is very necessary owing to the high compression under which the compressor is started. Pressure regulators are set on the wall adjoining the switchboard to control the starting and stopping of the machine. The air receiver is located just outside the building. As an auxiliary, in event of mishap to the large machine, a 9-in. Westinghouse locomotive type of air pump has also been installed, which has volume enough for all ordinary requirements. The entire passenger yard is piped for testing brakes on all cars.

For charging the batteries installed on the coaches for the electric lighting system a Canadian General Electric 15½ ampere, 550 volt, motor-generator set has been provided. This unit is equipped with automatic control by a set of magnets set at the desired voltage to avoid over-charging. At present only two tracks are available for supplying the batteries on the coaches, but should the necessity arise, facilities can be extended.

VACUUM CLEANING OUTFIT, MOTOR GENERATOR SET AND MAIN SWITCHBOARD.

An important requirement in passenger train service is the maintaining of the upholstery in the desired state of cleanliness, as an almost unavoidable feature in railroad operation is the accumulation of dirt and dust while the train is in transit. At this terminal the C. P. R. has installed a modern Sturtevant vacuum cleaning system for use in the coaches. The centrifugal suction fan is operated by means of a 7½ horsepower motor, and the apparatus is supplied with two receivers—one large tank outside for receiving the large particles and a smaller one forming part of the machine, into which the smaller dirt and dust is discharged. The entire passenger yard is fully equipped, so that cars in any location can be operated on conveniently.

With the exception of the vacuum machine, the engine room equipment is



PLAN OF POWER HOUSE SHOWING ARRANGEMENT OF PLANT.

BABCOCK & WILCOX BOILER INSTALLATION WITH UNDER-FEED STOKERS.

automatically operated, assuring continual service for yard operations, even in the absence of the power house engineer. The present building has been designed to accommodate sufficient machines to double the existing requirements, should future developments necessitate such increase of capacity.

SIBERIAN TRADE REQUIREMENTS IN OIL ENGINES AND MARINE MOTORS

L. D. WILGRESS, Canadian Trade Commissioner for Siberia, sends the following particulars from Omsk regarding trade in Siberia in oil engines and marine motors. It is hoped that these particulars will assist Canadian manufacturers of the products in question to determine the prospects for developing business with this market.

Trade in Engines

A considerable demand was created in Western Siberia before the war for oil engines designed for various farm uses, such as the operation of flour mills, threshing, the pumping of water, etc. Previously the demand in this branch of trade was chiefly for portable steam engines with colonial fireboxes, enlarged especially for burning wood. With the amount of wood available for fuel purposes, this was considered the engine most suitable for use in Siberia. The rise in the price of wood, the prevalence of alkaline water in certain districts and particularly the campaign conducted by Swedish and other manufacturers, gradually created a demand for oil engines, with the result that the number of portable steam engines sold each year remained stationary, while the trade in the former greatly increased. Lately the business in steam engines has been largely confined to dealers in power-threshing outfits. These have been chiefly of British and German manufacture, the largest sale being in sets with a nominal 10 horse-power, but an actual 36 horse-power.

Types of Oil Engine in Demand

The oil engines sold in Western Siberia previous to the war were chiefly of Swedish and Russian manufacture, supplemented by a limited import from Germany and Great Britain. These engines were either sold to co-operative societies for the operation of flour mills, creameries, etc., or to individual peasants for general farm purposes. For the operation of flour mills and similar heavy purposes, the most usual size required is from 32 to 40 horse-power. The largest demand, however, is for one-cylinder vertical motors of from 10 to 16 horse-power size, suitable for operating threshers, small flour mills and for other farm uses. During the summer the farmers use their engines for threshing grain and other purposes, while during the winter they grind the grain by operating small unit flour mills, using their oil engines for power. There is also a considerable sale of the smaller sizes of engines of from 4 to 8 horse-power, which are used for pumping water, operating threshers, etc. The tendency has been, however, for a greater number of the larger sizes of engines to be sold each year, since the economy of purchasing a somewhat larger engine is becoming recognized.

The fuel used for oil engines in Western Siberia is either kerosene or what is locally known as "naphtha." This latter is similar to what is sometimes referred to in America as crude oil and is practically kerosene before the benzine is extracted from it. Gasoline is too dear to permit of its use for fuel purposes in Siberia. Since the outbreak of the war the high cost of kerosene and naphtha has placed the owners of oil engines at a disadvantage.

The requirements of the market call for an engine which is above all things simple to operate. This is one of the objections held against certain engines of the North American type as compared with those manufactured in Sweden and Germany. There is also a prejudice among the Siberian peasants against the horizontal motor, it being held that the friction is greater than in engines of the vertical type. The accompanying illustration shows a 10 horse-power engine manufactured by a well-known German firm. This oil engine is of the type which has enjoyed the largest sale in this market. The retail price of this particular motor before the war was 1,800 roubles. A 5 horse-power engine manufactured by the same firm sold for 750 roubles. These prices may be taken as representative of the prices paid for oil engines in Western Siberia previous to the outbreak of the war.

Marine Motors

There should be an opening for the sale of Canadian marine motors in the Russian Far East. The development of the fishing industry of Eastern Siberia has led to an increased use of motor-propelled boats, while sailing vessels with auxiliary motor-power have proved to be the best suited for the trade along the coast where the population is very scattered. Motor-boats are also beginning to be used to a greater extent on the principal rivers of Siberia for purposes of communication and in connection with the fisheries. Motor-boating for pleasure is still in its infancy, although the sport appears to have gained a foothold in the principal towns. Motors of Swedish manufacture are chiefly to be seen, but it is reported that the sales of American motors are increasing in Eastern Siberia, where the conditions of competition are more favorable to Canadian and United States manufacturers. Kerosene is the principal fuel used, gasolene being too dear for general use. The type of marine motor required in Siberia is one of strong construction and simple design. All sizes are in demand varying according to the purposes for which the motors are to be used. The names of some of the principal dealers in Vladivostok may be obtained on application to the Department of Trade and Commerce, Ottawa.

TO PROVIDE POWER FOR MUNITION WORK

SOME improvement in the power situation in Ontario is expected to follow the appointment of Sir Henry L. Drayton as "controller of the production and distribution of electrical energy by companies generating or distributing electrical energy in the Province of Ontario."

His duties as defined in the order-in-Council will be "to determine preferences and priorities in the supply of such electrical energy to the end that a sufficient supply shall be furnished to factories and users engaged, directly or indirectly, in munition work or work for any of the allied Governments, and also

for municipal and public utility requirements."

As much of the electricity now exported from Canada to the United States is used in connection with the war requirements of the two countries and their allies, the British Ambassador at Washington will be asked to arrange for a conference between Sir Henry Drayton and the proper authorities in the United States with a view to insuring co-operation between the two countries in the generation and utilization of electric energy on both sides of the international boundary to the end that the maximum efficiency may be obtained.

Sir Henry Drayton's appointment follows his investigation of a serious power shortage in Ontario, disclosed to the Government by the Hydro-Electric Power Commission. Sir Henry was appointed a Royal Commissioner to make an enquiry into the extent to which electricity was exported by the generating companies at Niagara Falls, and the extent of the demand in Ontario. His report was considered by a sub-committee of the Cabinet and was discussed at a conference between the committee, Sir Adam Beck and representatives of the power companies. At the conference the basis of an order-in-council was agreed upon. That order recognized the desirability of maintaining the suppply of electricity for munition plants on both sides of the international boundry, some of which were complaining of shortages of motive power. It also recognized the necessity of providing for the demand from municipal utilities. The order will apply to the Canadian Niagara Power Co., the Electrical Development Co., and also to the Ontario Power Co. which, although acquired by the Hydro-Electric Power Commission, still retains its corporate entity.

Sir Henry was authorized by his Commission to report upon the status rights and obligations of the companies operating at Niagara Falls; the amount of power available for distribution by those companies at Niagara Falls; the extent of the demand for power in Canada; the amount of power in the past exported by the companies and the present demands of the United States customers. He finds that the Ontario Power Company, recently acquired by the Hydro-Electric Power Commission of Ontario was authorized to export power to the United States, subject to a requirement to retain one-half of the electricity, it generated, for sale in Canada at prices not to exceed those charged to customers in the United States.

NEW ELECTRIC LOCOMOTIVE

THE accompanying cut illustrates a type of electric locomotive recently built by the Montreal Tramways Company, for operation on various sections of their system where heavy haulage is often necessary. The total weight is approximately 85,000 lbs., and the drawbar pull is upwards of 25 loaded freight cars. A feature of the locomotive is the method of obtaining the desired weight; the steel framing of the platform, consisting of I beams and channels, has an area of about 246 square feet and a depth or thickness of 12 inches, the intervening space being filled with solid concrete, giving a weight in the frame alone of nearly 35,000 lbs. Tractive power is obtained by four 200 horse-power motors, two of which are installed on each truck. The electric equipment is located in one of the apartments adjoining the central operating cab, while the other contains the air pumps and other pneumatic appliances. The sand is forced to the rails by means of small injectors operated by compressed air. Every facility has been provided for the convenience of the engineer or operator. The general dimensions are as follows: Over-all length at drawbar connections, 31 ft. 8 in.; length of car body, 29 ft.; size of cabin, 9 ft. long by 7 ft. 4 in. wide, with a height from the floor of 7 ft. 7 in. The wheel base is 21 ft. 6 in., the centres of the trucks being 15 ft. apart.

ELECTRIC LOCOMOTIVE BUILT BY MONTREAL TRAMWAYS CO. FOR STREET RAILWAY WORK. IT WEIGHS 85,000 LBS., AND HAULS 25 LOADED FREIGHT CARS.

IRON WEAPONS OF THE AZTECS

WHEN Cortez had completed the conquest of Mexico, the Spaniards, among a great many other peculiar and extraordinary observations which they made in that remarkable country, were particularly struck and puzzled by one fact.

They noticed that the Aztecs possessed certain implements, such as knives, daggers, etc., made of iron, but it seemed that only the most distinguished of the natives possessed such, that iron was a great rarity and was prized higher than gold. At first the Spaniards believed that the Aztecs extracted the metal in some crude fashion from its ore, which abounds in many parts of the country, but they soon ascertained that this was not the case. They found that not a single smelting furnace existed in the empire, and their surprise was not small when they learned that the Aztecs were totally unacquainted with any method of extracting the iron from the ore, which, indeed, they had never suspected of any kinship with the highly valued metal.

The question whence the Aztecs had procured the little iron they possessed became a perplexing problem to the Spaniards, which they were never able to solve. The natives do not seem to have enlightened them much on the subject, for when asked they mysteriously pointed to the sky, and indicated that they obtained their iron from the regions above. Such assertions, no doubt, the Spaniards received with an incredulous smile, and they concluded that the Aztecs procured it by way of traffic from some other, perhaps more civilized, nation which they suspected to exist and kept looking for north and south for more than a hundred years.

It was left to modern science to unravel the mystery. The Aztecs were quite correct; the iron of which they had made their implements was not fashioned from materials of this terrestrial globe, but had come to them from the unknown regions of space. Their iron was, in fact, of meteoric origin, like that of the Mayas of Yucatan, and the Incas of Peru, of which many weapons are still preserved for collections.—Hensoldt.

FOR the protection of ironwork paint is generally used and provided that rusting has not commenced a paint composed of four parts of red lead, one part white lead ground in oil and at least five years old and sufficient raw linseed oil of good quality will be found very efficient if used when freshly made. No driers are needed, as the red lead is a very good oxidising agent, but the paint takes several days to dry and harden. For ironwork red oxide of iron also makes a good paint if no driers are used and the oil is good, but if driers are used the paint soon fails when exposed.

Comparison of Working Costs of Principal Prime Movers*--I

By Oswald Wans

High thermal efficiency does not necessarily imply commercial superiority. Available data are seldom complete and render difficult the justification of claims and working costs advanced by advocates of respective prime movers. The engine of lower thermal efficiency may, therefore, under certain conditions, be the sounder proposition commercially.

THE problem of economical power is one that must repeatedly present itself to those responsible for the welfare of industrial concerns, or indeed to any one upon whom falls the onus to provide power for whatever purpose. Yet the available data are seldom complete, and are frequently misleading. The claims and working costs advanced in favor of the several prime movers are often conflicting and difficult to reconcile with fact. It is not suggested that a lack of good faith is responsible, as an analysis of such estimated costs generally reveals the fact that the explanation is to be sought in the too limited basis upon which the costs have been founded. The condition that a certain type of engine possesses an exceptionally high thermal efficiency does not necessarily establish its commercial superiority. On the contrary, an engine of lower thermal efficiency may, under favorable conditions, be a sounder proposition from the commercial standpoint, and this in practice is the ultimate criterion of the engine's worth.

Working costs based mainly upon the low rate of fuel consumption are practically useless, and although the statement may be termed obvious, nevertheless, not infrequently one finds that the capital charges are either inadequately covered or entirely ignored. One may allege, without feeling, that the advocates of internal-combustion engines have been the greatest offenders in these respects, but it must be acknowledged that nowadays the undertakings of manufacturers generally are based upon broader lines, due doubtless to the accumulated data consequent upon a more extended experience.

The object of this paper is to give data that will be of service in estimating capital expenditures and working costs, and in establishing the relative commercial value of the principal prime movers. For this purpose typical examples of the following prime movers will be considered:

Suction-gas engines and plants burning anthracite, coke, and wood refuse.

Gas engines using town gas.

Oil engines of the solid injection high-compression type.

Diesel engines.

Steam engines.

The scope of the paper includes units up to a working load of 500 b.h.p., a power range embracing the engines for which there is by far the greatest demand. For higher powers two or more units can be used sometimes with advantage, for such installations possess a considerable power flexibility, in that the units may be cut out or put into service to suit the load requirements. This facility largely obviates the disadvantages of underloading, particularly valuable in the case of an internal-combustion engine, and offers a further advantage in the event of a break-down of one unit, for a complete stoppage of work may be prevented. In a multi-unit installation the expenditure and working costs may be taken as proportional to the number of units.

It is desirable to confine the present paper to the power units indicated, as the factors governing the costs of the larger installations are distinct, for example, the possibility of using bituminous coal with a recovery plant, live and exhaust steam tubines, etc., should be considered, thus introducing another set of conditions. It is perhaps hardly necessary to state that working costs, to be of commercial value, must contain the charges due to capital expenditure, depreciation, etc., as well as those arising from the direct running expenses. Further, the latter should be founded upon "everyday" performances; the results of "kid-glove" tests should be carefully avoided.

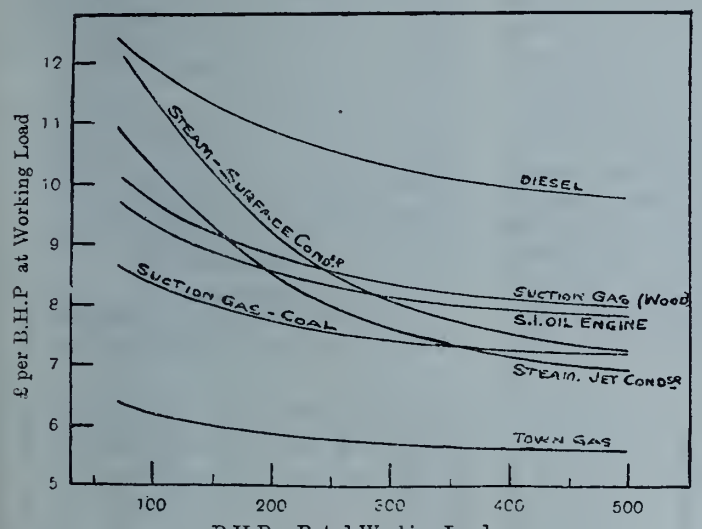


FIG. 1.—EXPENDITURE CURVES.

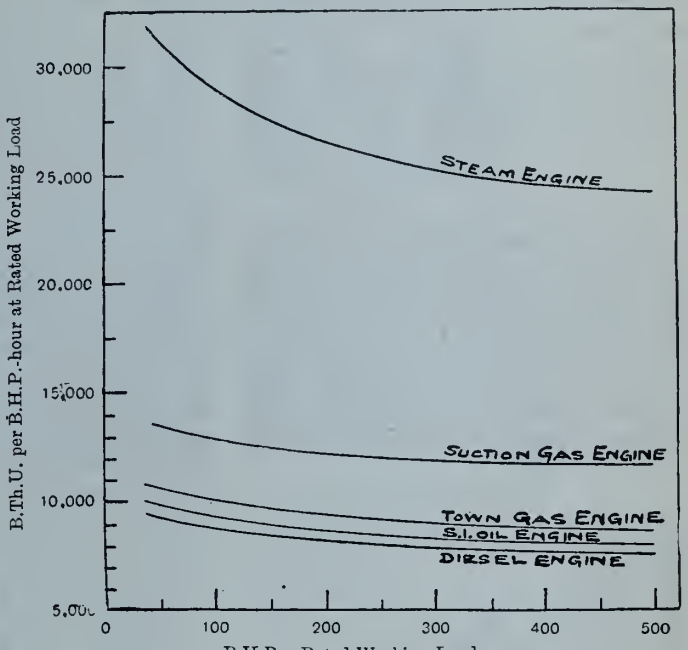


FIG. 2.—FUEL CONSUMPTION CURVES.

The items constituting the total working cost are:

- **Capital Charges:**
  - Depreciation.
  - Insurance.
  - Interest upon capital expenditure.
- **Running Charges:**
  - Cost of fuel.
  - " " lubricating oil.
  - " " water supply.
  - " " sundry stores.
  - " " labor.
  - " " repairs.

(Total working cost)

It is necessary to determine firstly the capital expenditure and this factor therefore will be dealt with at once and

*Read before the Institution of Mechanical Engineers, London, Oct. 19, 1917.

the remaining charges in the order tabulated. The charges arising from rent and taxes must be considered in addition, but owing to the wide variation in their amounts, it is not possible to make allowance here. They can be determined with accuracy only after a full investigation of the local conditions.

Capital Expenditure

The capital expenditure should cover the total cost of the completed installation in working order. The following list gives the items included in the expenditure curves, Fig. 1.

Installation	Items included in Expenditure
Suction gas engine. Town gas engine. Solid injection oil engine. Diesel engine.	Industrial engine, pulley, foundation bolts, compressed air starter with receiver and connections, exhaust pipe and silencer, barring gear, cooling tower, tanks, water circulating pipes and pump, foundation erection.
Additional for suction gas engine.	Producer,, cleaning plant and charging platform, air and gass piping, producer foundation and bolts, erection.
Additional for town gas engine.	Gas bag, connections, and air piping.
Additional for solid injection oil engine and Diesel engine.	Fuel tanks and piping.
Steam engine.	Industrial jet and surface condensing super-heated steam engines, barring gear, foundation and bolts, steam, exhaust and feed piping, boiler, seatings and flues, super-heater, feedwater heater and pump, steel chimney, economiser for 150 b.h.p. and upwards, erection.

It will be observed that buildings and flooring have not been included. These exemptions are made, as their cost varies widely, being largely dependent upon the taste of the purchaser, and may, therefore, range from a bare galvanized structure to a substantial stone or brick building. Furthermore, existing buildings are frequently used with more or less modification.

The cost of the buildings for internal-combustion engines would be less than for a steam plant, and this applies equally to suction-gas engines, for the producer and cleaning plant do not require a covering, whereas some form of protection is necessary for a boiler. A well-equipped engine-house should possess a crane, but the cost of this item is dependent to a certain extent upon the proportions of the engine-house, and has consequently not been taken into consideration, but its cost would not be materially different for the several types of engines. Cooling towers have been included in all cases, with the exception of the small gas and oil engines of about 50 b.h.p., as the more usual practice is to employ cooling tanks suitable for thermo-syphon circulation.

When deciding the size of the engine, it is necessary to consider its overload capacity, for this factor greatly affects the capital expenditure, the reliability, and the fuel economy. It may be remarked in passing that much of the trouble at times experienced with internal-combustion engines is solely due to excessive overloading. That gas and oil engines should have a large power margin is an essential of reliability and cannot be too strongly emphasized. The effect of the overload capacity upon the economy of an installation is dealt with later, and for the present merely its influence upon the capital expenditure will be examined. The maximum overload that may be depended upon varies considerably with the type of engine, thus:

Steam engine.....35% above rated working load
Solid injection oil engine .....15% above rated working load
Diesel engine.....15% above rated working load
Gas engine.....10% above rated working load

The larger overload carried by a steam engine is a characteristic of considerable value in the handling of fluctuating and peak loads. Moreover, this advantage is attained without impairing the fuel economy at the working load. Unfortunately this feature is not possessed by an internal-combustion engine. An overload of 35 per cent. may be carried, but only at the expense of the fuel economy at the mean working load, which in the case of a gas engine would be about 18½ per cent. below the rated working load.

The degree of importance to be attached to the overhead capacity of an engine can be decided only after full consideration of the duty required, but for the purposes of comparison it is necessary that similar load conditions are considered for all installations. A common maximum load of 35 per cent. above the mean working load consequently has been assumed, and the effect upon the capital expenditure is illustrated by the following table:

Plant	Rated Working	Rated Max.	Necessary Inc. in Rated Max. Load to give 35 per cent. overload
	B.H.P.	B.H.P.	
Steam engine.....	100	135	Nil
Oil engine.....	100	115	17½ per cent.
Diesel engine....	100	115	17½ per cent.
Gas engine.....	100	110	23 per cent.

For a mean working load of 100 b.h.p. and 135 b.h.p. maximum load it will be seen from the fourth column that a larger internal-combustion engine is required than is indicated by the rated working load. For example, the gas engine must have a maximum load some 23 per cent. greater than the rated maximum load usual for a 100 b.h.p. rated working load engine requiring, it follows, a larger engine and outlay than appears at first sight to be necessary.

The expenditure curves, Fig. 1 (page 309), give the total cost per b.h.p. at the rated working load, and from which it will be seen that the cost of suction-gas engine and plant of 100 to 110 b.h.p. is £8.3×100 = £830 as against £8.1×123 = £997 for a 100 to 135 b.h. engine. That is to say, the cost of the gas engine is increased by approximately 20 per cent. in order that it may perform a duty equivalent to a steam engine of 100 b.h.p. rated working load. This example serves to illustrate how necessary it is when comparing capital expenditures to place the comparison on "all fours" as regards power capacity.

The expenditure curves are based upon the costs of horizontal engines, excepting Diesel engines, but would not be greatly different for the vertical type. Generally speaking, vertical engines cost more per horse-power, but a saving is effected in the cost of the foundations.

Depreciation

A divergence of opinion appears to exist as to the annual charge that should be made to cover depreciation. The seller naturally wishes to place as favorable a complexion as possible upon the engine in which he is particularly interested, and it is to be feared that this

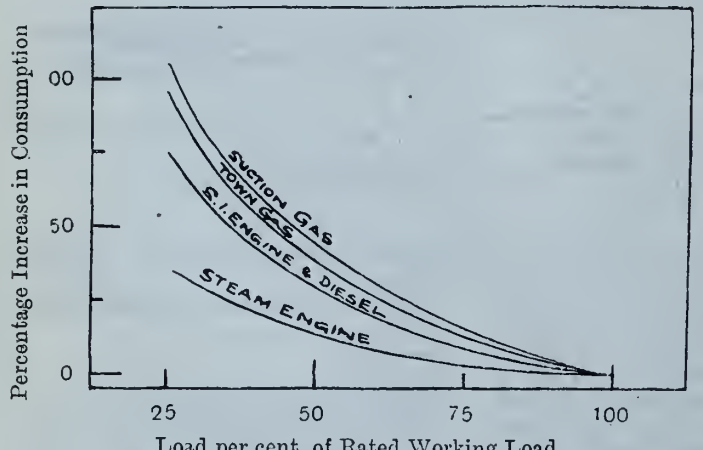


FIG. 3. CONSUMPTION AND LOAD CURVES.

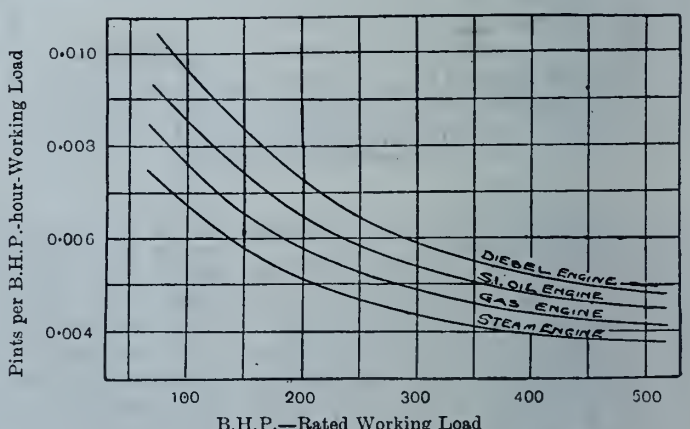


FIG. 4. LUBRICATING OIL CONSUMPTION CURVES.

desire tends to under- rather than over-estimation of the charges under this heading. Generally speaking, the estimated costs of steam installations show a greater uniformity and liberality in this respect than is usual with internal-combustion engines. As an example of

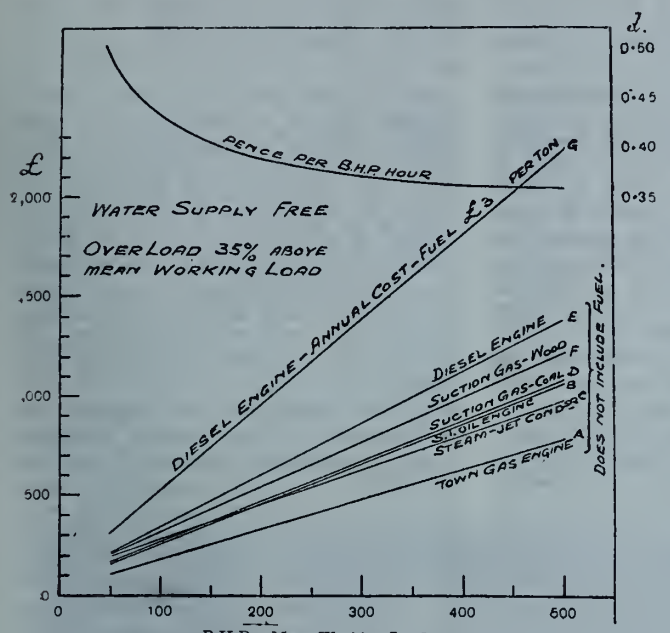


FIG. 5. WORKING COST CURVES.

originally installed. Yet it is surprising how often one finds an antiquated engine struggling along with its load, and positively eating money that could be saved by substituting a modern plant. The depreciation of 5 per cent. referred to above corresponds to a life of well over fifty

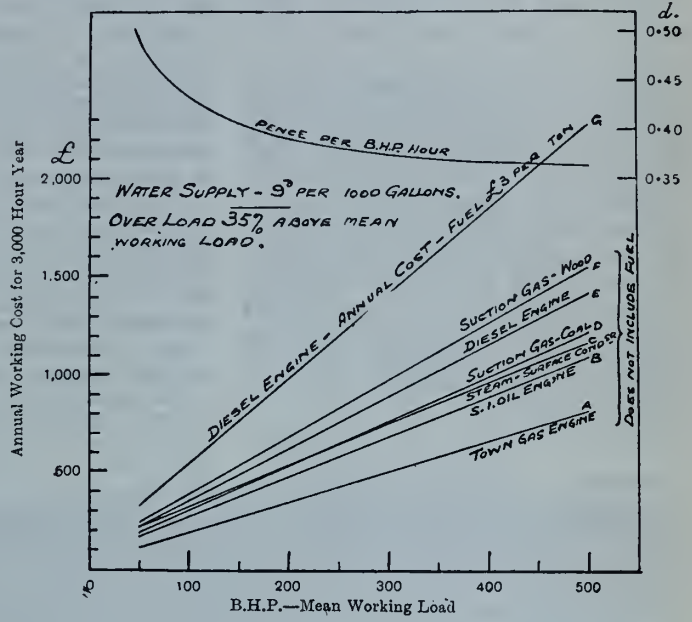


FIG. 6. WORKING COST CURVES.

the low rate for depreciation for the latter, the not uncommon charge of 5 per cent. may be cited. A little reflection should show how inadequate a provision this affords. It will be well to explain briefly what is here implied by the term depreciation. The depreciation charge is considered as the annual amount that should be written off the capital expenditure to cover the deteriorating value of the plant as regards obsolescence. This definition does not agree with general usage, inasmuch as wear and tear are not included.

In the author's opinion this departure is justified because:

(1) Developments are nowadays so rapid that there is an increasing tendency for a power plant to become economically obsolete before it is worn out.

(2) The allowance made for repairs should be sufficient, in a modern engine, to cover wear and tear during its economical life whilst serious breakages should be covered by insurance.

Viewed from these standpoints, it follows that the depreciation charge is solely dependent upon the anticipated economical life of the installation. In other words, it is not a matter of how many years an engine may run, but for what period it can be reasonably expected to maintain its economical superiority over competing prime movers irrespective of type. Immediately this superiority is lost, the commercial value of the installation, as a source of power, falls and the advisability of replacing it by an up-to-date plant should be considered.

It is false economy to keep a plant in service merely because it continues to perform the duty for which it was or-

years, if based upon the diminished value and allowing a high scrap value or about twenty years if taken in equal annual instalments. In either case the anticipated life is obviously excessive. The determination of this period must, in the nature of things, be somewhat prophetic, nevertheless the past, to a great extent, is an index to the future, and it may be inferred that an internal-combustion engine before the expiry of twenty years' service would be an extravagant consumer of fuel, and in a generally worn-out condition; indeed, this would be equally true of a steam installation.

The depreciation rate should spread the expenditure burden over a reasonable number of years, and permit in good time of the removal of the power plant in favor of a more modern type, should the developments in later-day practice render the running costs comparatively high. It is considered that a uniform annual rate of 8 per cent., equivalent to twelve and a half years' service, fulfils these conditions, and that this rate should apply to all the prime movers under consideration, seeing that the commercial life is dependent upon the best practice, irrespective of the type of engine. The amount written off annually is, therefore, 8 per cent. of the total expenditure given by the curves, Fig. 1 (page 4).

It should be noted that this uniform rate is intended to apply to cases in which the several prime movers under consideration are applicable and, therefore, in competition. The competitive factor applies to the large majority of installations, but there may be instances in which the working conditions render especially suitable a particular type of prime mover, thus eliminating this factor and thereby deferring the probable date at which the plant may be considered obsolescent.

Insurance and Interest

The cost of insuring an installation is a small item and varies somewhat with the power unit and the insuring company. The insurance premium for engines usually covers breakage, but not wear and tear, and this fact should not be lost sight of when fixing the annual reservation for repairs. The premiums range from about one-eighth per cent. of the cost in the case of boilers to about 3 per cent. for Diesel engines. The charges under this heading are therefore comparatively small, whereas the accruing advantages are self-evident. The rate of interest upon the capital expenditure has been taken as 5 per cent. in the working costs, curves Fig. 5 and 6.

Cost of Fuel

As already stated, estimated working costs, founded upon the fuel consumption possible at the most economical load, are of little value. Everyday figures only should be considered, and failure in this respect is frequently the cause of erroneous estimates. In practice the engine seldom runs at the rated working load, having to cope alternatively with loads that may be temporarily greatly in excess and at other times considerably less. These practical conditions have a marked bearing upon the working costs, and particularly so in the case of an internal combustion engine.

The accompanying curves, Fig. 2 (page 10), show the average consumptions in B.Th.U. per b.h.p. hour at the rated working load. These values, however, hold good only when these loads are carried continuously, and the extent to which modification is necessary to suit practical conditions is contingent upon the load factor and the peak loads to be

handled. These factors may vary widely, consequently each case must be considered upon its merits, but to effect a comparison a common overload of 35 per cent. will be assumed again. This condition necessitates the underloading of all the installations with the exception of the steam plant, that is to say, the mean working load will be below the rated working load to an extent dependent upon the maximum load capacity of the unit

This underloading increases the consumption, and the curves, Fig. 3, show the average percentage increase for a given decrease in load below the rated working load.

These curves clearly indicate the importance of the correct determination of the load factor, and the absolute necessity to consider similar load conditions in order that a true comparison may be made. The following table shows the increase in full consumption due to the underloading necessitated by an overload of 35 per cent:

Installation.	Percentage of mean working load below rated working load	Increase in consumption due to underloading from Fig. 3
Steam engine	Nil	Nil
Diesel engine	14.5	2.5
Oil engine	14.5	2.5
Suction gas engine...	18.5	12.0
Town gas engine.....	18.5	8.0

A farther allowance must be made for stand-by losses, which will depend upon the frequency and length of the stoppages. This loss of course applies only to suction-gas and steam installations, and the amount may vary considerably according to the care exercised. The following values, expressed as a percentage of the fuel consumption at the rated working load for a working week of 60 hours, have been included in the working costs, surves, Fig. 5 and 6.

	per cent.
Suction-gas installations, anthracite	8
Suction-gas installations, wood	6
Steam installations	15

In cases where the plant runs continuously throughout the week, the losses would be considerably less and would be about one-third, assuming that the boiler or producer fires are kept alight over the week-end.

THE MARCH OF PROGRESS

By C. I.

THE development of any particular branch of industry generally divides itself into three separate parts, which are sufficiently well-defined to enable the stages to be marked with exactitude. The first stage is that in which the process of trial and error predominates. The machine or engine produced is the product of experience. Continued observation in working, alteration of detail and rearrangement of elements constitute the methods by which a degree of perfection is obtained. So-called theoretical considerations play no part in this stage of development, the instinct or experience of the designer or operator being the deciding factor in all changes. In the second stage, the whole subject is minutely examined from a purely technical standpoint, and the reasons which underlie the various peculiarities in construction or operations are critically scrutinized so that some rational basis for future work may be arrived at. In this stage of development the product of experience will be found to be developing on wrong lines, and in defiance of certain truths which can be scientifically demonstrated. Or it may be that these truths are ascertained for the first time as a result of these investigations. The third stage of development is that in which the work of the pure scientist is turned to practical account, and in which designs and processes are modified to bring them into agreement with the results of scientific investigation. It is in this third stage that the great competitive race is run, and where firms and individuals who refuse to be guided by the most up-to-date scientific factors must come to grief.

There are many fields of labor in which the first machines are based on exact scientific facts and where, therefore, there are but two chief stages of development, but on closer investigation it will be found that in the thousand-and-one different branches which constitute one field of labor the three stages of progress are continually taking place. Thus, in the realm of machine tools, the first machine produced was one that would stand up to its work and give fair results in accuracy and quantity of production. Then when high-speed steel forced an investigation of the question of cutting power, and the forces at work during cutting, it was found possible to improve the design of the machines, increase speeds and also production. As the late Professor Nicholson once wrote: "The necessity for any serious application of theory or calculation in the design of machine tools was probably never felt until the universal adoption of high-speed steels. which rendered the reconsideration of the kinematical and dynamical principles governing design a matter of careful and of vital importance. A careful study of machine tool design from the theoretical side can be of substantial assistance to the successful designs. A complete knowledge of the forces operative, and the power required in performing a given piece of work, and of the most economical rates of cutting and feeding, taking into account all the factors which contribute to the total cost, must certainly be obtained and made use of, if the design is to stand absolutely secure in subsequent successful and useful employment."

Steam Generator Developments

In steam generator practice, the use of big flues and slow speeds of gases has been used so long, so as to allow a long period of contact of gas and plate, that it seemed as though this practice must be based on correct scientific facts. Many forms of spiral retarders were devised to increase this time of contact, and gave good results, but probably not for the reasons conceived by the inventors. Most probably for the very opposite reasons which the investigation revealed, namely, that the rate of heat transmission increased with the increase of gas speed, and that what was required was not a large volume of gas having a small surface area of contact with plate and a large control core which transmitted heat to the plate only by radiation, but a large volume of gas broken up into small streams drawn at very high speeds over the metal so as to yield all its heat by convection and do away with a slowly moving film in contact with the plate which acted as a heat insulator. The spiral and other retarders inserted in fire tubes had this effect in part, for they split up the gases and prevented the formation of a central core of gas, giving off heat by radiation only. So far theory has not found much practical application, but prejudice will be broken. The Lancashire type of boilers has advantages, and men are naturally reluctant to alter such an old friend; similarly in other fields. In agriculture, the farmer's idea of the action of his manure has been critically examined and found to be less promising than the new theories based on the action of nitrifying bacteria, with the result that new products, such as bacterized peat, are finding their way into service. So in all branches, including sewage treatment and water filtration, steam turbine engineering and air pump construction, the results of the second stage of the march of progress are always being brought forward for attention.

The necessity, therefore, for a thorough grounding in the theoretical side of the subject of one's life work, and the great value of a technical scientific training for the evolution of new inventions of merit, is one of the facts that these present days of the world's history are making increasingly evident.

PORTLAND cement, a constantly growing necessity, was first made in England in 1824. The name is taken from the resemblance of the mortar to the oolitic limestone of Portland Island, in the English Channel. The industry was later taken up in Germany. In both countries it grew enormously, and at the beginning of the present war the output in Germany amounted to 20,000,000 barrels annually, and that of England about half as much. Portland cement was first made in the United States at Coplay, Pa., in 1878, and since then works have been established in nearly every State in the Union. The growth of the industry is perhaps the most marvellous thing in the whole industrial development of this country. No farther back than 1894 the product was small.

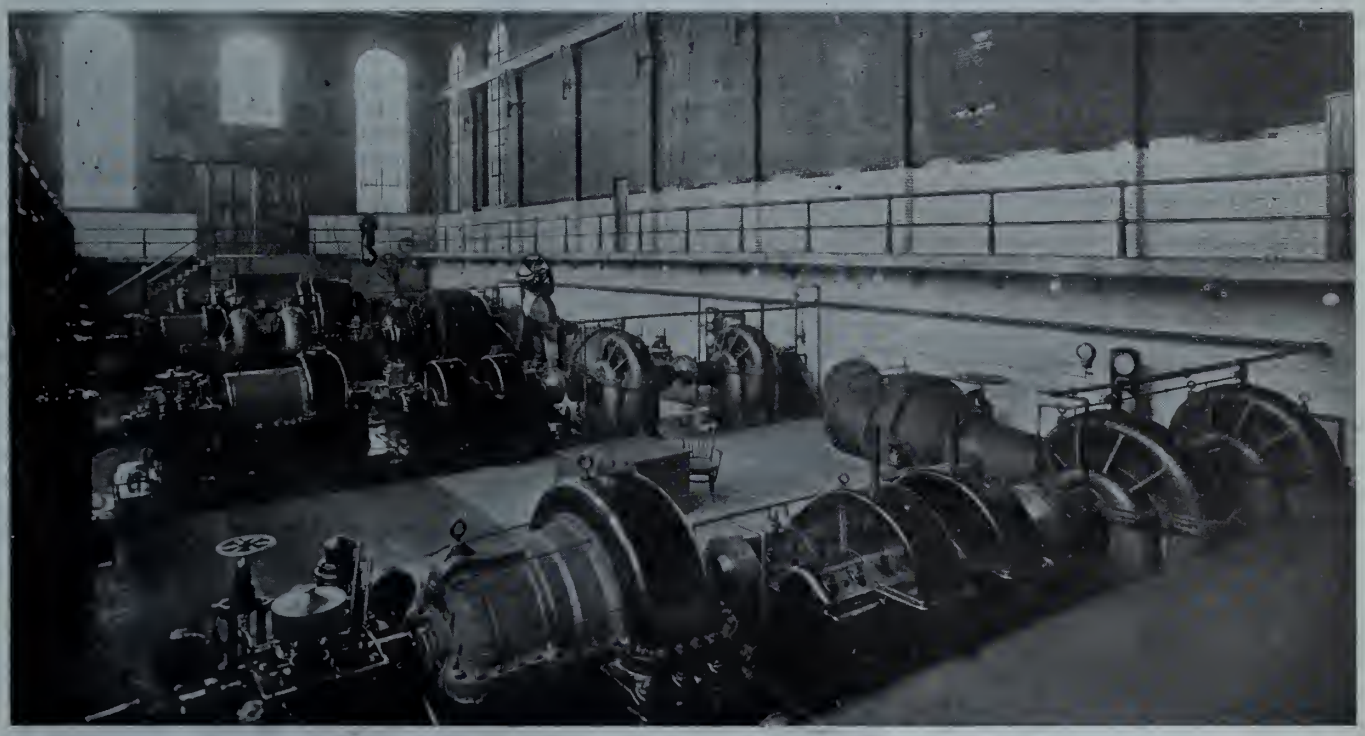
WHEN the babbitt is being run directly into bearings, the shell should be heated to about 100 degrees to prevent blowholes. A Brinnell hardness of 23.5 for lead base and 30 for tin base alloys is considered best.

Duty Trials on Two 24-Million Gallon Pumping Units

Contributed

The pumping engines whose performances are recorded in the following report are driven by De Laval steam turbines, and form part of the installation at the Main Pumping Station, Toronto Waterworks. The duty trials were made March 6 and 8, 1917, by Robert W. Angus, professor of Mechanical Engineering, University of Toronto.

ALL of the water used by the City of Toronto is pumped through the Main Pumping Station at the foot of John Street. This station is equipped with a number of steam driven pumps and also a number of electrically driven units, the latter receiving electric current from the general city supply. In so far as the electrically driven units can be operated without raising the city's power peak, they are kept in service, but whenever the electrical operator finds that the peak is being approached, he has one or more electrical pumps stopped and then the delivery pressure of the station may slightly decrease while a steam pump is being brought into service, but, on the whole, these variations in pressure and in supply are not noticeable in the city.



GENERAL VIEW OF PUMPING WITH UNITS UNDER TEST IN FOREGROUND.

Description of the Units

Some few years ago it was decided to increase the pumping capacity of the Main Station, and, with this in view, a new pump room with adjacent boiler room was built. The pump room now contains five pumping units, two of which are driven by induction motors, and three of which have been built by the De Laval Company, and are driven by steam turbines. It is with two of the latter pumps that the report deals.

Each unit consists of a De Laval steam turbine connected through a reduction gear to a pair of centrifugal pumps, which are connected so as to work in series.

The units are exact duplicates.

The turbines are of standard De Laval construction, type 1,600 T. D., for steam pressure of 150 pounds, and a vacuum of 29 inches, the normal speed being 3,430 revolutions per minute. Each is direct-coupled to a speed reduction gear having a ratio of 33 to 197, so that the pump shaft rotates at normal speed of 575 revolutions per minute.

The steam supply pipe is 4½ inches, with 36-inch exhaust to a standard Wheeler surface condenser, so placed that all the water delivered by the unit passes through it as cooling water before reaching the main pumps.

The vacuum pump is a 20-inch x 40-inch Rotrex pump built by the C. H. Wheeler Company, and is direct connected to a 7-inch x 7-inch engine designed for a normal speed of 200 revolutions per minute, but which ran at a much lower speed during the trials. The exhaust from this engine is delivered back into the steam turbine somewhere near the middle stage, and is made use of in doing work there.

The boiler feed pump is chain driven from the pump shaft. It is a Goulds single acting triplex plunger pump with plungers 3½-inch diameter and 6-inch stroke, and in one of the units the crank shaft driving the plungers turns at about 47 revolutions per minute, a speed which is too low to supply the necessary feed to the boiler for this pumping unit; in the other unit the speed is 66 revolutions per minute, which is satisfactory.

There are two single stage double suction pumps on each unit, the two pumps being piped together in series. There are no outside guide vanes, but the castings are of the volute form and the pumps run very quietly. The name plate states that the pump is of Type P-24, and is designed for a total head of 250 feet, and a discharge of 20,000 U.S. gallons per minute (which is equivalent to 24,000,000 Imp. gallons per 24 hours) at a speed of 575 revolutions per minute.

The water piping begins with a 42-inch suction, which is the size of the inlet to the condenser. At the condenser outlet the diameter is reduced to 36 inches and this is again reduced to 24 inches where it enters the pump. The series piping between the pumps is 30 inches, being reduced to 24 inches at the point of connection with each pump. To the discharge end of the pump a 24-inch x 36-inch tapering enlarger has been

attached to connect with the 36-inch discharge main. The inlet and outlet openings on all the pumps are 24-inch diameter.

The pump impellers are of bronze.

The Duty Trials

The duty trials on the machines were run on March 6th and 8th, 1917, respectively, and in order to see that the conditions were uniform before the tests began, the machines were run for at least an hour under full load immediately preceding the duty trial.

The boiler fires were properly cleaned, and everything put in as good condition as possible to insure uniformity, but some slight variations naturally occurred. It was necessary to run the trials during the daytime, owing to the demand for water in the city, and therefore an effort was made to start as near seven o'clock in the morning as possible, although in both cases the trials did not begin till nearly an hour later.

The city's electrical power peak occurred shortly after the trial began in each case, and the electrical pumps were therefore shut down, causing a heavy draught on the pump under test. There was a consequent decrease in pressure, but as the discharge increased at the same time, the load on the steam turbine driving the pump did not vary greatly. Throttling of the pump discharge was temporarily resorted to, in order to prevent undue fluctuations, and another steam pumping unit elsewhere in the station was put into service as quickly as possible, but the extra draught of steam from the boilers caused some slight variations in steam pressure.

All of these variations, however, were of short duration and were productive of but slight inconstancy in the general conditions, and the machines were given exceptionally steady loads during their entire trials.

Conditions Governing the Trials

In the contract dated August 14th, 1914, the conditions governing the conduct of the duty trials are given, and the following clauses referring thereto are copied here for reference:

"54. Each turbine shall have sufficient power capacity when connected by flexible or other approved coupling to the centrifugal pump to raise from the suction conduit directly into the pipe system of the city not less than 24 million Imperial gallons of water in 24 hours, against a pressure difference of 107 pounds per square inch between suction and discharge mains, the pressures to be measured at approximately the same level.

"57. The turbine to be designed for speed not in excess of 4,000 revolutions per minute, and the centrifugal pump to to be operated at speed not exceeding 600 revolutions per minute, with provision for a ten per cent. (10%) increase in speed, if necessary.

"58. The pumping capacity of the unit shall be determined by Venturi meter measurement, and if the capacity of the unit, when running the pump at a speed not in excess of 600 revolutions per minute, and a turbine speed not exceeding 4,000 revolutions per minute, is less than 24 million Imperial gallons, the Commissioner may deduct from the amount to be paid to the contractor two and one-half per cent. (2½%) of the contract price for each one per cent. (1%) less than the specified capacity, at the specified pressure, and pro rata for fractional parts.

"If the capacity as shown by the official trial of the unit does not reach 92% of the specified capacity, the Commissioner may, at his option, reject the unit, and in case of such rejections the contractor shall return all moneys paid him on account, and shall, without compensation, allow the unit to remain in the service of the city and under the control of the commissioner for such reasonable time as may be required to install a new unit.

"The steam turbine driven unit shall perform a duty of not less than one hundred and twenty million (120,000,000) foot pounds for each one thousand (1,000) pounds of steam containing less than 1½% of entrained water, as determined by throttling calorimeter measurements, used by the engine and any auxiliary pumps supplied by the contractor and operated during the duty trial, when pumping not less than 24 million (24,000,000) Imperial gallons in 24 hours.

"In computing the duty, the work performed by the unit shall be based upon Venturi meter measurement. The head for computing the duty shall be that shown by an accurate pressure gauge attached to the discharge main at a point inside the engine room and beyond the last pump, less the reading shown by a gauge attached to the supply conduit at or near entrance to pumps, an allowance being made for any difference in the level of the gauges. No allowance shall be made for friction of water between the gauge points, between which shall be situated the complete machine as supplied by the contractor.

"In computing the duty, the total steam used, including that used by jackets, air pumps, air compressor, boiler feed pump and any other auxiliary pumps, shall be charged up to the engine. No allowance shall be made for any heat returned to the boilers derived from the exhaust steam from the turbine or from any auxiliary.

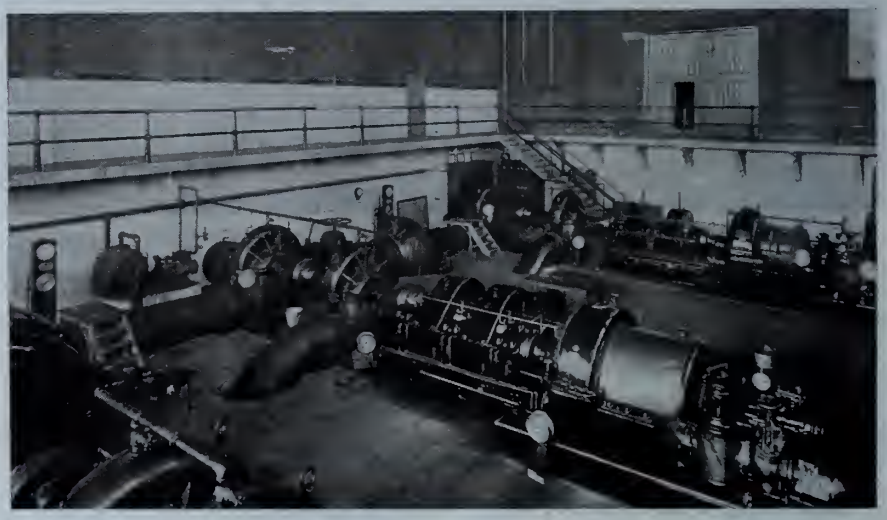
"After the unit has been in successful operation for sixty (60) days, a duty trial of 24 hours' duration shall be made. The unit shall be operated continuously at its rated capacity, against a pressure difference of 107 pounds per square inch as above specified, and shall be supplied with steam of not more than 150 pounds per square inch, by gauge, at the boiler, and containing not more than 1½% of entrained moisture.

"During the trial the unit shall be operated by the regular engineers of the station, at the speed and pressures specified, but otherwise shall be under the control of the contractor. The trial shall be conducted by the Commissioner, or persons appointed by him, in the presence of a representative of the contractor. The city shall pay all expenses of the trial, except that the contractor shall pay his own men.

"If the duty shown by the official trial of the steam turbine driven unit shall be less than 120,000,000 foot pounds, the Commissioner shall deduct from the amount to be paid the contractor the sum of $2,500 for each 1,000,000 foot pounds unperformed below 120,000,000 foot pounds, and pro rata for fractional parts down to 115,000,000 foot pounds.

"If the duty shown by the official trial of the steam turbine driven unit shall be less than 115,000,000 foot pounds, the Commissioner may, at his option, reject the unit; and in case of such rejection, the contractor shall return all moneys paid to him on account, and shall, without compensation, allow the unit to remain in the service and under the control of the Commissioner for such reasonable time as may be required to install a new unit.

"If the duty as shown by the official trial of the engine exceeds 120,000,000



VIEW OF UNITS UNDER TEST FROM OPPOSITE DIRECTION.

foot pounds, the city shall pay to the contractor the sum of $1,500 for each 1,000,000 foot pounds above the stipulated duty, and pro rata for fractional parts, but the bonus shall not exceed $7,500.

"59. While the duty specified for the steam turbine driven unit is 120 million foot pounds, tenderers are requested to state any higher duty they are prepared to guarantee, and any higher duty guaranteed, together with the contractor's ability to fulfil same, in the opinion of the Commissioner, will form a factor in the awarding of the contract. Should the contractors guarantee a duty in excess of that specified, when using saturated steam containing not more than 1½% of entrained moisture, the duty guaranteed will be substituted for this amount, and for each one million (1,000,000) foot pounds in excess of the guarantee the corporation shall pay to the contractor the sum of fifteen hundred dollars ($1,500), and pro rata for fractional parts, but the total bonus shall not exceed seven thousand five hundred dollars ($7,500). Should the duty as shown by the official trials be less than the guarantee the Commissioner shall deduct from the amount paid to the contractor the sum of two thousand five hundred dollars ($2,500) for each one million (1,000,000) foot pounds unperformed, and pro rata for fractional parts down to five million foot pounds less than the guaranteed duty.

"If the duty as shown by the official test be more than five million foot pounds below the guaranteed duty, the Commissioner may, at his option, reject the unit, and in case of such rejection, the contractor shall return all moneys paid to him on account and shall, without compensation, allow the unit to remain in the service and under control of the Commissioner for such a time as may be required to install a new unit, and shall fully reimburse the city for any loss or damage suffered by reason of the contractor having failed to fulfil his guarantee."

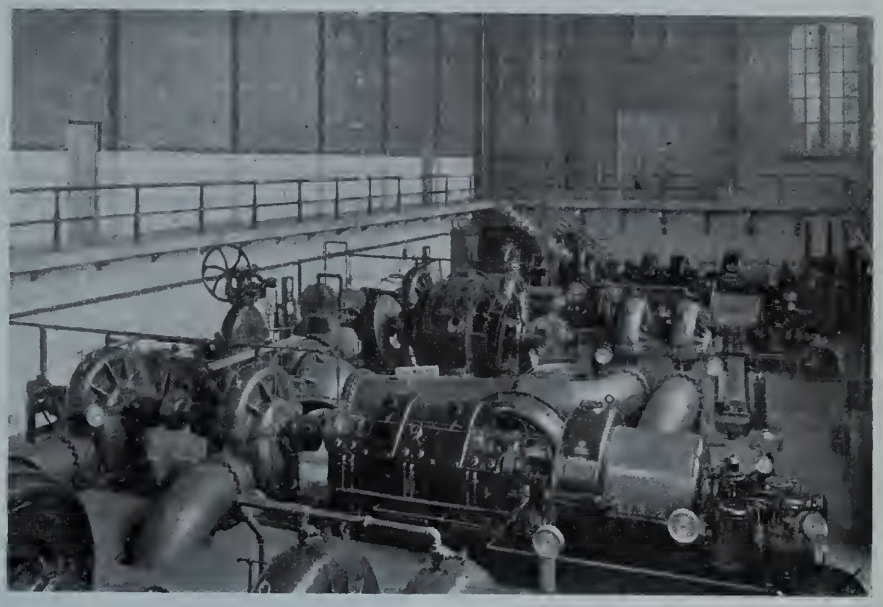
In accordance with clause 59, the contractors guaranteed a duty of 141.5 million foot pounds of work per 1,000 pounds of stream used, and this duty was therefore inserted in the contract.

Details of the Trials

The duty trials were run in exact conformity with the specifications, with the single exception of the duration of each, which is specified as twenty-four hours. On discussing the matter with the city's engineers, it was found that the conditions in the station made such a long run very undesirable, and it was agreed that the run should be shortened to ten hours. The contractor agreed to this, and a copy of his letter relating to the matter accompanies this report.

There is no doubt that the results for the ten-hour period would be practically identical with those for twenty-four hours.

The specifications require that the gauge pressure on the boilers supplying the turbines shall be 150 pounds per square inch. A battery of four boilers was used in each case, and on top of each boiler there is a stop valve bolted to the steam drum, and from the top of this stop valve the steam pipe from the boiler leads to a header which is common to all boilers. To this header the supply pipe for each pumping engine is connected by a fairly long, well-lagged pipe.



GENERAL VIEW OF STATION. NOTE ELECTRICALLY-DRIVEN PUMP.

To avoid any possible sources of loss in the boiler stop valve, the gauge used on the trial was connected to the steam pipe within six inches of the stop valve. The gauge pipe was so arranged that the gauge was brought down to the level of the fireman's eye, and correction was made for water column. An observer remained constantly in the boiler room so as to keep this pressure uniform, and readings were noted every 15 minutes.

The quality of the steam was taken by throttling calorimeter attached to the steam pipe about six inches from where it entered the turbine stop valve. For the purpose of determining the quality, the engine pressure was taken and is also recorded; it was taken at the point where the calorimeter was attached. These readings were at 15-minute intervals.

Exhaust Pressure and Temperature

To determine the exhaust steam condition, both a mercury column and a thermometer were used, the mercury column being attached to the turbine casing slightly below the level of the main shaft, while the thermometer was inserted in a cup in the exhaust pipe about half way between the turbine casing and condenser. Much care was taken to push the thermometer well into the cup, so that the bulb was at least 9 inches in from the pipe wall, and the mercury column connections were also carefully tested for leakage. A comparison of the two readings given in the table herewith shows that the temperature is lower than that corresponding to the mercury column, possibly due to the difference in location, and partly to the presence of air in the exhaust. Both results are quite accurate and equally reliable.

Speeds

The speeds were taken with an ordinary revolution counter, or else were actually counted, those on the main pump being at 15-minute intervals; the others were not so frequent. It was not possible to get the speed of the steam turbine directly, and hence it had to be calculated from the pump speed, using the gear ratio given by the contractor of 197 teeth in the gear to 33 teeth in the pinion. The pump and turbine speeds were well below the maximum specified.

Steam Used During Trial

To get the steam used during the trial, the ordinary pipe for delivering the condensate into the feed tank was broken and a connection put in so that the water was delivered into a storage tank, from which it was run into a tank on scales as desired. The leakage from the air pump glands was caught and has been added to that coming directly from the air pump discharge. There was only one trap on the turbine plant, and, as it was plugged, no leakage occurred there.

On the first unit tested the gland leakage was not great, but as it was in the form of steam it could not be measured. In the second unit the leakage was much more marked, due to defective carbon rings, but the steam thus escaping would not have formed any appreciable proportion of the total, and its effect on the duty would be very slight.

The weighing tank was capable of holding a net weight of only about 1,000 pounds, and, in order to keep well within the limits, the weight of steam condensed every three minutes was taken. In order to have no error due to the storage tank, the water in it was brought to the same level at the end of the test

as at the beginning. All weights were taken to half pounds.

The steam used by the air pump is automatically included with that from the turbine, and the feed pump was chain driven from the pump shaft.

Water Pressures

For convenience and greater accuracy the pressure and suction gauges were both piped to the same point, close to the suction inlet pipe, and in the results allowance was made for the difference in levels between them.

Before the test began, considerable discussion took place between the contractors and myself regarding the position of the discharge gauge connection, and also as to whether velocity head was to be allowed for. In this connection it is pointed out that the suction pipe up to the condenser is 42-inch, and the discharge outlet from the pump 24-inch, and a tapering enlarger and valves are used to connect the 24-inch pump outlet to the 36-inch delivery pipe provided by the city. The difference in pressure between the two ends of this enlarger was slightly over 7/10 pound per square inch, being greater at the 36-inch end, and amounted to about 7/10 of one per cent. of the total head.

The nature of the specifications prevented allowance being made for difference in velocity head between suction and discharge pipes, and it was also agreed that the discharge connection should be placed on the outlet from the pump where its diameter was 24-inch, and the results are reported on this basis.

The discharge pressures were taken with a sensitive Bourdon gauge, and the suction pressures by mercury manometer; there was always a slight pressure in the suction pipe at its centre line.

Both readings were taken every five minutes, the discharge gauge being carefully calibrated.

Measurement of the Water Pumped

The specifications required that the water pumped should be measured by Venturi meter, and both of the pumps discharged through a 36-inch meter with 21-inch throat. The quantity was calculated from readings of a mercury manometer, using the coefficient supplied by the Builders Iron Foundry, the makers of the meter, who state that a manometer reading of 5.07 inches of mercury corresponds to a discharge of 25.30 millions of Imperial gallons daily.

Readings were taken on the manometer at five-minute intervals, and in order to check the recorder for the meter, readings were also taken on it, and the results are included for reference.

Observers and Representatives

The observers were all fourth year students in engineering at the University of Toronto, and were well skilled in the work required.

The contractors for the units were the Turbine Equipment Company, Toronto, who were represented by their manager, Mr. Austin, and also by Messrs. Salt and Petersen of the De Laval Turbine Company, Trenton, who designed the machinery and built much of it. The writer represented the city of Toronto, and personally conducted both the trials, and desires to express his thanks for the co-operation of the above parties, and also of Mr. James Milne, Mechanical and Electrical Engineer of the Works Department.

Remarks on the Trials

The results obtained on the units are a matter of great satisfaction, partly because they have so far exceeded the guarantees of duty, and partly because the results are exceptionally high for this class of pumping unit, and have probably not ever been exceeded by any similar unit running under similar conditions of steam and of equal water pressures. The city is to be congratulated on having pumps which will give such good results.

Respectfully submitted,
ROBERT W. ANGUS.

Toronto, March 20th, 1917.

GENERAL DIMENSIONS OF THE UNITS. BOTH ARE EXACTLY ALIKE.

Turbine—	
Normal speed .....revs. per min.	3,430
Diameter of steam pipe.....in.	4.5
Diameter of exhaust pipe .....in.	36
Double Helical Reduction Gear—	
Number of teeth in pinion.....	33
Number of teeth in gear.....	197
Ratio of teeth	5.97
Pump speed corresponding to turbine speed above	575
Pump—	
Number of stages	2
Suction and discharge openings....in.	24
Suction inlet to condenser .....in.	42
Size of City's discharge main.....in.	36
Enlarger from pump discharge to main .....in.	24x36
Rated speed .....revs. per min.	575
Air Pump—Wheeler Rotrex—	
Size .....in.	20x40
Size of direct coupled driving engine .....in.	7x7
Rated speed .....revs. per min.	200
Feed Pump—	
Goulds Triplex Single Acting—	
Size of plungers .....in.	3½x6
Speeds in the two units..revs. per min.	47 & 66

RESULTS OF TRIALS.

	Westerly Unit No. 10	Easterly Unit No. 9
Date of trial 1917	March 6th	March 8th
Duration of trial.....hours	10	10
Aver. barometer reading.in.	30.06	29.43
Pounds per sq. in.	14.77	14.45
Pressures and Temperatures—		
Average boiler pressure—lbs. per sq. in.	149.4	148.4
Steam pressure at the turbine —lbs. per sq. in.....	144.7	144.6
Pressure in the calorimeter— lbs. per sq. in.	1.36	1.38
Temperature in the calorimeter —deg. F.	294.8	300.2
Moisture in steam at turbine— per cent.	0.66	0.35
Vacuum in exhaust chamber— in.	29.33	28.69
Temperature of steam in exhaust pipe—deg. F.	60.3	61.9
Water Pressures—		
Suction pressure as read—lbs. per sq. in.	0.89	1.19
Delivery pressure near suction pipe level—lbs. per sq. in...	107.34	107.97
Difference of gauge levels reduced to—lbs. per sq. in...	0.79	0.40
Net pressure produced by pump —lbs. per sq. in.	107.24	107.18
Net pressure specified—lbs. per sq. in.	107.0	107.0
Quantity of Water Pumped—		
Size of Venturi meter tube—in.	21 x 36	21 x 36
Average manometer reading— in. mercury	4.895	4.99
Corresponding discharge—millions of Imperial gallons per 24 hours	24.86	25.10
Specified discharge — millions of Imperial gals. per 24 hrs.	24.00	24.00
Dial on recorder gave—millions of Imp. gals. per 24 hrs...	24.80	24.99
Speeds—		
Aver. pump speed—revs. per min.	582.6	574.8
Corresponding turbine speed— revs. per min.	3,478	3,431
Average air pump speed—revs. per min.	151	147
Feed pump speed, double strokes each plunger	66	47
Water Horse Power—		
Net pressure produced by pump lbs. per sq. in.....	107.24	107.18
Discharge — million Imperial gals. per 24 hours.....	24.86	25.10
Work done per hour— foot pounds 2,562,679,427		2,585,972,052
Corresponding water horse-power 1,294.3		1,306.0
Steam Used per Hour—		
Steam condensed during test, including drips—lbs. 169,803.5		168,010.0
Steam used per hour—lbs....	16,980.3	16,801.0
Steam used per water horse-power hour—lbs.	13.14	12.88
Duty—		
Work done per hour— foot lbs. 2,562,679,427		2,585,972,052
Steam used per hour—lbs.....	16,980.3	16,801.0
Duty obtained—millions of ft. lbs. of work per 1,000 lbs. steam used	150.92	153.92
Duty specified	141.5	141.5
Amount that the unit exceeded the guarantee under specified conditions—millions of foot pounds	9.42	12.42

ROBERT W. ANGUS.

Toronto, March 20th, 1917.

ADVANTAGES OF OIL FUEL LOCOMOTIVES

By O. C.

IN the case of a locomotive burning oil fuel, the fire can be instantaneously adjusted to suit the load, which varies almost from minute to minute with the speed and gradient. So perfect is the control that the steam pressure can be maintained inside a total variation of five pounds with changes in load of 50 per cent. and over. An important feature is the rapidity with which a head of steam can be obtained; an engine can be moved under her own steam within 35 minutes of the full oil-burners being lighted. The practice on railways using oil is to have a stationary boiler always in steam at each round house, from which connection is made to the dead engine through a three-way cock in the steam pipe leading from the steam stand on top of the fire-box to the burner. By this means the burner can be started from cold until there is sufficient steam generated in the engine itself to keep the burner going.

The advantages of the use of oil are specially noticeable in the round house or shed when squaring up after a day's work. There are no fires to be raked out; no flues or soot boxes to be cleaned; no coal to be stacked, weighed or otherwise handled. A saving in cost of equipment is represented in the absence of fire-rakers, flue brushes and shovels all of which are unnecessary on an oil-burning locomotive. Further, when engines are engaged in switching and shunting operations, they frequently have to stand idle under steam for hours at a time. The burners in such cases can be cut down to the minimum, or even extinguished, as an engine will always retain sufficient steam to start up the burners again when required.

Modern Steam Power Plant and Its Appliances--I.

By John H. Hale*

Despite the wonderful developments of hydro-electric power generation, the modern steam power plant occupies a firmly established position in engineering effort from which its removal, if it take place at all, will never be more than temporary. The economies possible in large plants and the duty of all engineers to adapt such methods to their small individual plants wherever possible is emphasized by the writer.

THIS subject is of indirect and personal interest to the owner and engineer of every power plant. The intention is, if possible, to awaken to a conscious realization what is in a majority of cases an utterly careless and indifferent attitude to the engine and boiler rooms under their care. To some, it may seem that there is not much involved, and that other and more pressing questions come forward for adjustment first. I want to ask you,—"Are your engine and boiler rooms all they should be: All they might be?" And do each of you realize that they are at present what you have made them?

Initial Errors

A great many mistakes are made in laying out and building a steam plant, not only from inexperience, but also from trying to reduce the first cost of installation. As you are all aware, any apparatus or safety appliance can be installed far more cheaply before the plant is in operation than afterwards; and the safety appliances should be considered not only in large plants, but also in any small plants. The question arises—"Is it necessary when you are building a plant for yourself to have these safety appliances or mechanical devices?" This question must be considered very carefully by the engineers in charge, also the owner of the plant. First of all, every plant cannot have the same mechanical devices, as nearly every plant is run under different conditions and for different purposes.

Another mistake made when installing a plant is that of trying to do the work too quickly. The company that is waiting to have the plant in operation is impatient and sometimes you have not the material on hand that you should have, and many times you have to make a temporary job, to get the plant started at a few hours' notice, and cannot get the chance later to change the work that was not done properly in the first place. Operating a plant under the above mentioned conditions may be a great loss and disadvantage to you, financially and practically. Then if you want to make any change, it means a shutting down of your plant for a certain amount of time, sometimes much longer than you expected. There you have another loss, which sometimes runs to a large amount.

In very many cases, certain mechanical devices, or appliances, in connection with a steam plant, are condemned by the engineer in charge. It is quite true that some of these mechanical devices are not answering the purposes they were intended for, but I am sorry to say that a great many power plant owners do not consider the position from the point of view of those in charge of their plants. A great many mechanical devices and other machinery are condemned by inexperienced men, as they believe anything mechanical should work mechanically without attention.

As stated before, some of these devices may not be suitable for your plant and conditions, but may be of first-class service for a different plant for which they are intended, and for this reason before condemning any of your machinery or appliances, make a careful investigation, to see if they were made for the purpose you want them. Are they large enough? Do you give them proper attention? Inquire of other plants of your type and size, and you will be in a position to correct these aforesaid troubles.

JOHN H. HALE.

Engine Room Appearances

Visiting an engine room will give you a fair indication of the engineer in charge, and with this most of you will agree. The engine room in which the distinct knocks tell of each revolution the engine or engines are making, the hiss of steam from leaky joints, the tools, oil, water and waste lying all over the floor all indicate in a fairly reliable way what the engineer is in action and appearance without seeing him.

It is not necessary that tiled floors and white enameled brick walls should be part of the equipment, but it is necessary that every engineer should see that the plant of which he has charge is kept in such manner that it does not reflect injuriously on him and his work, in the eyes of his present or prospective employer; and these latter should see to it that an engineer and his engine room do not impress unfavorably an outside estimation of themselves. This may be prevented by their insisting on cleanliness and tidiness in everything pertaining to the power plant, and their encouragement and recognition, of the engineer doing so. Boiler rooms generally suffer more than engine rooms, due largely to a poor layout, in the matter of access and light for inspection, and being thus under a cloud as it were, do not draw attention or criticism to the same extent. Not enough interest is taken in them by engineers, and, in fact, their absence from them is marked. This should not be allowed, because they have graduated from the coal shovel, and, while naturally proud of the achievement of having left it behind, they should not be lacking in care for the boiler room, as this is the most dangerous and most important part of the plant.

We will go a little farther into the economy question, which is very important. When a large manufacturing company is building a new factory, the first question, generally, is the power question—How they can buy or generate cheap power, so they may compete with other manufacturers?

It would take too much time and space, if I were to take this question in detail from the smallest to the largest power plant.

The Larger, the Cheaper

It is well known that the larger the power plant the cheaper the power may be generated. However, from 15 per cent. to 40 per cent. increase in efficiency could be derived from the majority of small plants by proper care and proper attention. There are a number of stokers on the market, and from practical experience it will be found that the highest efficiency in regard to firing is obtained from automatic stokers.

At the Grand Trunk shops power plant, we are equipped with four chain grate stokers, built by the Green Engi-

*Executive Secretary, Canadian Association of Stationary Engineers.

neering Co. of Chicago. Each grate has an area of 72 sq. ft. I personally consider this stoker one of the greatest labor savers on the market to-day, under normal conditions. Now this automatic stoker having a grate surface of 72 sq. ft. can burn say 18 lbs. of coal per sq. ft., and suppose the demand for steam increases, and you have to increase the feed of your coal, say from 18 lbs. to 20 lbs. per sq. ft., is it possible for you to get the same efficiency, not only from your coal, but also from your boilers, when you are overloading your stokers and boilers?

You have to travel the stoker at a great speed, and the result will be that a large amount of combustible will run down to the ash pits, your combustion chambers will not be large enough to effect combustion of the extra amount of coal, and the temperature of the flue gases increase, and the result is that your efficiency is escaping through the chimney. To be equipped with alarm column for low water, and high water, is a great advantage, especially for small power plants, in which, I am sorry to say, you will not find the engineer or man in charge in his boiler-room except when he comes around to put on a fire, or oil up his machine; then maybe he will have to go to repair a belt, etc., and sometimes does not go to the boiler room till the alarm whistle notifies him that the water may be too high or too low in his boiler. As I said before, this device is a great advantage, but I may say it is, or rather may be, a great disadvantage also; for if this, or any other kind of water column is not blown down at different times during the day, it may choke up with mud, with the result that the water level will remain the same, and the alarm whistle will not blow. In most of the new power plants, small or large as the boilers may be, the man in charge may depend on this alarm to warn him, but he may wait too long, and before he gets back his tubes or boiler may be damaged, or possibly blown up. It is a very good policy for a steam plant to have a recording steam pressure guage connected with the water column, as it will record every time that the man in charge blows down the water column.

Feed Pumps

A very important item of boiler equipment is the pump or other device for feeding the boilers with water. In a great many power plants you cannot find more than one pump for this purpose and this is a very great mistake. Every engineer knows that if this boiler feed pump fails the whole plant has to be shut down to prevent a boiler explosion or rather other damage, due to running too long with low water in the boilers, while trying to get the pump in operation without shutting down the plant. For this reason, not only every engineer, but also the plant owner should insist upon having a duplicate set of pumps or other devices for feeding water to the steam boilers, not only to prevent shutting down, but also for the prevention of further serious damage.

THE EFFECT OF SPELLERIZING ON THE LIFE OF STEEL TUBE

THE beneficial results on the longevity of steel tube manufactured by the spellerizing process are pointed out in an article in the "Compressed Air Magazine," the process having been devised to overcome the tendency of corrosion in the smaller sizes of steel piping in which the greatest corrosion in service occurs on account of the thinness of the metal. Large sizes, being made from heavier plates of more uniform quality are not so seriously affected by corrosion.

The process consists in subjecting the metal bloom to the action of rolls having regularly shaped projections on their working surfaces, then subjecting the bloom while still hot to the action of smooth faced rolls and repeating the operation, the surface of the metal thus being worked so as to produce a uniformly dense texture better adapted to resist corrosion, especially in the most objectionable form of pitting. The process is quite analogous to the kneading of dough and operates upon the metal all through instead of merely on the surface. The aim is to make the metal uniform and without the spots of varying texture from which pitting results.

Uniform Results

As the process is entirely mechanical and does not in any way depend upon the skill of a workman, uniform treatment and results are assured. The process is applicable to the smaller sizes of pipe, say up to 4 inch.

Pipe has been made by this process for ten years in increasing amounts. The official records of the American Iron and Steel Institute show that during this period the percentage used of steel pipes has increased from 74.3 to 87.9 per cent.

Appended are some special experiences as to the use of this process and its effect upon steel pipe in actual service.

H. J. Macintire, Professor of Mechanical Engineering, Washington University, says in Power:

"In the case of ordinary steel pipe, mill scale is always present, and this likewise is electro-negative to the iron. If this scale is evenly distributed, as in Spellerized steel, the self-corrosion on its account will be slight; but if it is segregated, then local electrolysis and pitting of the material will result."

Morgan M. Smith, in the October, 1913, issue of *Ice*, states with reference to the merits of the Spellerizing process:

"Steel pipe, which has been treated in such a manner as to eliminate or at least distribute evenly the mill scale may be joined with wrought iron or cast iron safely as a rule. The same stock without the treatment for mill scale will show a decided tendency to corrode when joined with wrought iron or cast iron. The so-called Spellerized steel fulfills this condition with respect to the scale."

R. B. Duncan, associated with the United Gas Improvement Company of Philadelphia, Pa., in a paper "Installation and Maintenance of Service," read before the Ninth Annual Meeting of the American Gas Institute, 1914, states:

"The steel industry has been developing a new process which, after several years' time, has given many encouraging results. By this process the steel is treated mechanically and does not in any way depend upon skilled labor, beyond keeping up the machinery involved, hence uniform treatment is assured.

"This new process is a method of treating metal which consists in subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surfaces, then subjecting the bloom, while still hot to the action of smooth faced rolls and repeating the action whereby the surface of the metal is worked so as to produce a uniform dense texture better adapted to resist corrosion, especially in the form of pitting."

The Gas Record, (issue of September 23, 1914, page 222) in commenting on Mr. Duncan's paper in regard to the Spellerizing process, says:

"The consensus of opinion is that modern steel pipe, particularly if Spellerized, is as durable as wrought iron, and is, besides, cheaper, stronger and more ductile and more uniform in composition."

Pipe steel made in 1906 by this roll-knobbling process tested against pipe steel made in 1897 resulted not onl yin a somewhat greater loss of weight by corrosion of the latter, but a decidedly deeper pitting of the 1897 steel in six months than occurred in the 1906 steel in thirteen months. In comparison with wrought iron it was found that the two materials lost practically the same weight by corrosion yet the steel had the advantage of uniform corrosion since the "wrought iron skelp pitted in seven months much deeper than the steel did in thirteen months." (Prof. H. M. Howe, Am. So. for Testing Materials, 1908).

A. Sang, in a thorough resume of the question, entitled "The Corrosion of Iron and Steel" (McGraw Hill Book Co., New York, 1910), says:

"The carefully acquired experience of the largest manufacturers of tubes in the world, which induced them recently to abandon the manufacture of wrought iron pipe, teaches that the use of steel in place of iron, at least in the United States, for the special purpose of tubing is to be preferred; the tendency of steel to pit is somewhat less than that of iron and it welds at the joint fully as well."

"There is very little, if any, difference between the corrosion on the wrought iron and the corrosion on the steel pipe. If anything, the wrought iron is pitted a little deeper, i.e., the pitting on the steel pipe is probably more general all over the surface, but the pitting on the wrought iron pipe is deeper in spots that are affected." (Proc. American Gas Institute, Vol. III, 1908, page 274).

Electricity and Hydraulics

WORLD'S MOST POWERFUL LOCOMOTIVE

IN the vicinity of Philadelphia the Pennsylvania Railroad Co. has been testing the world's most powerful locomotive. This locomotive is capable of exerting a maximum horsepower of 7,000, and is intended for the mountain grade electrification between Johnstown and Altoona, Pa., around the famous horseshoe curve. During a recent test this locomotive hauled a train of 68 cars, and the regular large Mikado type of road locomotive. The steam locomotive, however, remained idle.

The mechanical parts of this electric engine were built by the Pennsylvania Railroad Company at their Juniata Shops at Altoona, Pa., and the electrical equipment supplied by the East Pittsburgh works of the Westinghouse Electric & Mfg. Company.

THE MOST POWERFUL ELECTRIC LOCOMOTIVE IN THE WORLD.

To equal the power of this locomotive it would take 100 trolley cars, or 14,000 horses, or 56,000 of the strongest men. Enough electric current is consumed bl it to light over 200,000 25-watt electric lamps; and many a town of 25,000 people has an electric light plant of smaller capacity. This is possible because of the high voltage alternating current used in distributing the strong electric power.

Exerting its maximum pulling force this locomotive will develop 7,000 horsepower, which is greater than its closest electrical rival can do. This locomotive, which weighs 250 tons and is slightly over 76 feet in length, is the first of a type that will be used on the Altoona Grade Electrilcation of the Pennsylvania Railroad, between Johnstown and Altoona, around the famous Horse Shoe curve. Two of these locomotives are able to haul a 6,000-ton train up this mountain grade at a speed of slightly over 20 miles per hour, thus relieving, when necessary, the congestion that seems apparent in that freight traffic over this division now, which is unusually heavy, amounting to as much as 300,000 tons per day. In addition to the heavy grade over the Alleghany Mountains a long tunnel, which helps to form the "narrow neck in the bottle" in operating over this division, must be passed through.

By electrification the expense of grade reduction has been eliminated and the capacity of the division will be more than doubled.

The Westinghouse Electric equipment is so designed and built that these locomotives can haul the heavy trains up hill and coast down hill at the same speed of 20 miles per hour. By the motors becoming dynamos or generator in the latter case effective braking action results without the use of air brakes, which prevents runaways. This coasting speed can be regulated just as speed up-hill or under power. Air brakes are therefore not needed while coasting, and are simply held for emergency use and for bringing the train to a full stop.

ELECTRIC POWER GENERATED BY EARTH'S HEAT

A REPORT comes from Italy of a new and unique application of Nature's resources to produce power in commercial quantities. It consists of the utilization of the steam, whch at various localities where hot springs abound is seen issuing from cracks and fissures in the earth's surface.

As far as known, no effort was ever made to exploit this source of energy previous to developments which were begun in Italy a few years preceding the war. The heavy demand for power which the manufacture of munitions created in that country and the apparent necessity for conserving fuel led to the more extensive developments of the scheme.

According to an article in "The World's Work," the reservoirs are tapped at their source by boring through from 300 to 500 feet of hard rock and conducting the steam to the surface in iron pipes. The temperature of the steam issuing from these bores varies from 150° to 190° C. at a pressure of between 2 and 5 atmospheres. Owing to the corrosive action of the acid salts in its composition, it is impossible to use the natural steam in a prime mover, but by passing the steam through the aluminum tubes of a vertical, multitubular boiler ordinary water steam is produced at 2 atmospheres pressure. The steam thus generated in the boilers is conducted, on its way to the turbines, through aluminum pipes, heated outside by a current of natural steam at 180° C. and becomes superheated to 150° C. Aluminum is unaffected by the acidic action of the natural steam.

The turbines are low pressure, exhausting to surface condensers, the circulating water being cooled by a cooling tower. The condensed steam is returned to the boilers.

It is estimated that if the various volcanic heat-producing areas of the world were thus developed, many thousands of horse-power could be generated.

At the present time the installation at Voltera is capable of generating 15,000 horse-power of electrical energy, which is transmitted to Florence and a number of other cities and towns.

SULPHUR FROM GAS ENGINES AND ELECTRICAL EQUIPMENT

By T. J.

IN the search for the economic generation and use of power, the association of gas engines as prime movers with electrical apparatus is becoming more

and more general. There is certainly much to be said in favor of this, and therefore it is all the more necessary to face such difficulties as crop up in actual practice, as frank recognition of drawbacks usually lead to the discovery of means to overcome them. Now, one of the points that calls urgently for consideration is the fact that power houses which are equipped with large gas engines, especially those working with furnace, coke oven or producer gases, present troubles in connection with the maintenance of the switch gear and electrical plant. Something is constantly getting out of order, necessitating renewals, perhaps at awkward moments, and proving in the aggregate fairly expensive. These troubles it will be found, are due to the sulphur in the atmosphere, which attacks the switch contracts, and also affects the insulation of the windings of the machines.

So far it has been found practically impossible to prevent the sulphur laden atmosphere getting to the windings of alternators, but, of course, the switch gear and transformers, etc., may be placed some distance away from the engines, and further protected by being immersed in oil. These simple precautions usually prove effective. But the question of protecting the insulation of windings has still to be solved. This is one of a number of small points of which account has to be taken when installing gas engines, but which advocates of gas engines for any and every purpose generally omit to mention.

This is the wrong spirit in which to approach such problems, in this instance, proving harmful to the advance or the use of both class of apparatus. What is required is further experimentation, both with standard materials and with substitutes therefor.

Experience has of late taught that it is a mistake to assume that any one substance is the inevitable and the only one suitable for any special purpose. Actual practice has for years been handicapped by accepting certain existing conditions as those which must limit the work in hand. Other methods and substitute materials, which have long been held taboo, have been used under the stress of circumstances and discovered to work very well. It is, therefore, unwise to assume that the producer gas is hopelessly inimical to the working of electrical plant in close proximity.

MOTIVE POWER IN NORWAY

By L. E.

THE industries of Norway have been very seriously affected by the coal shortage and the restricted imports from Great Britain, and have been compelled to solve the most difficult of many problems with which they have been faced by utilizing the natural resources of the country. Considerable attention has therefore been concentrated on the development of plants for the generation of electricity by waterpower. The future of Norway as an industrial country will depend, next in importance to the cheapness and abundance of the water power and shipping facilities, on the supply of raw materials, or to what extent the electric power used by the industries will make Norway independent of importing raw materials necessary for the industrial life of the country. Norway has no coal deposits, and is therefore absolutely dependent on the import of this raw material for its industries. As a producer of heat units coal has hitherto provided all industries, and it is here where the electric furnace as a producer of motive power will take the place of coal.

Use of Electricity

One of the most important experiments which has been under discussion and has been tried on a large scale is the replacement of the old blast furnaces, with their large consumption of coal, by the electric furnace in the manufacture of pig iron. Two-thirds of the coal consumed in the manufacture of pig-iron is used for obtaining the necessary temperature for the reaction, whilst one-third of the coal is consumed purely as a chemical agent for the reduction of the iron-oxides. By the use of electricity it would therefore appear that two-thirds of the coal consumption should be saved. Although the use of electric furnaces for the manufacture of pig iron has been fairly successful in Sweden, the attempt in this direction in Norway was a failure.

As to the cause of the failure there exists a great difference of opinion amongst experts, some giving the lean iron ore as the cause, some the construction of the furnace and the electric arrangements in connection with the same, whilst others are of the opinion that for electric pig-iron manufacture it will be necessary to use the high-grade, comparatively scarce, and expensive charcoal instead of coke, which last one will, so far as Norway is concerned, have to be the necessary kind of coal. By the use of the electric furnace in the manufacture of pig-iron and steel, there will, however, always be need for the use of coal, as the electrical heat replaces only the coal used for obtaining the heat, whilst still one-third of the coal consumed in the blast furnace will be consumed in the electric furnace doing the chemical work.

Coal Not Displaced

Although the use of electricity will play a great part in this manufacture, the consumption of coal will not entirely be replaced by electricity, and Norway will in this line of industry be dependent upon import of one of the raw materials. The consumption of coal, as now practiced in the copper blast furnaces, can be wholly replaced by the electric current. Norway has abundant deposits of copper pyrites, the mining of which is Norway's most important mining industry. The use of coal in smelting the copper pyrites is solely for the purpose of furnishing heat, and the electric smelting of copper ores is nothing more than the substitution of electric heat for the heat derived from the combustion of coal.

TRANSMISSION LINE PROTECTION

A SPECIFIC illustration of some protective measures which are deemed necessary to guard against lightning on transmission lines in high altitudes is represented by the constructional features of an electrical transmission line across the Andes Mountains in Peru, as described in the "General Electric Review."

The line in uestion, which transmits 3 phase electrical energy at 20,000 volts over a mountain summit of 16,000 ft. elevation, is run on iron poles spaced 150 ft apart. It is found necessary to use 50,000 volt porcelain insulators owing to the fact that lightning disturbances occur almost every day in the year.

The telephone line is run on a separate pole line about 250 ft. from the power line and has a grounded return.

The lightning arresters at the power station entries are of the horn gap type, connected from line to ground through a resistance. A second set of horn gap arresters are connected between phases to take care of surges on the line.

ELECTRICAL NOTES

Induction Motor.—It is proposed to instal a 3-phase, 220-volt, 60-cycle, 730 r.p.m. induction motor, belted to an overhead line shaft. The shaft is 3 in. diameter and 90 ft. long, and runs at 200 r.p.m. It carries 16 pulleys belted to a total load of about 30 h.p. The belts before starting are put to loose pulleys, so that the load on the motor at starting will be simply the friction load of the shafting. It is desired to know what size and type of motor should be purchased.

In deciding on the type of motor, it will first be necessary to know what percentage of full load torque is required at starting. This may be obtained by fixing a lever arm to the shaft and adding weights at the end of the arm until the shaft begins to turn. Then the weight in pounds multiplied by the length of the lever in feet will give the starting torque required in foot pounds. To compensate for the friction caused by side pull of the motor belt on the driving pulley a belt could be run from the driving pulley to another loose pulley, so that the tension would be about the same as in actual service. Knowing the starting torque and the full load torque, it follows that the type of motor used must be such as to provide this multiple of full load torque for starting. The maximum possible starting torque in a squirrel cage induction motor will run, on average motors, about 1.5 full load torque. In the wound rotor type it is always possible to develop a starting torque three or four times as great as the full load torque, if the proper amount of resistance is inserted in the rotor or secondary circuit. In this particular case the starting inertia is not great, and a 30 h.p. squirrel cage motor with starting compensator will probably prove a satisfactory equipment.

Efficiency, Torque, Horsepower.—Refering to an electric motor, what is meant by (a) the efficiency; (b) the torque; (c) the horsepower?

(a) The efficiency of the motor at a given load is the ratio of the power in watts supplied to the motor or as it is more commonly expressed, the percentage ratio of the electrical output to the electrical input. Thus:—

$$\text{efficiency} = \frac{\text{watts output}}{\text{watts input}} \times 100\%.$$

(b) The ability of an electric motor to do useful work is due to a force which tends to rotate the armature as long as the electric current is supplied to the motion. The armature shaft transmits this turning effort to the pulley which drives the belt and is said to exert a torque. The pull on the belt in pounds multiplied by the radius of the pulley in feet gives the torque in foot pounds. Thus, if, at the circumference of a pulley of 1 ft. radius, the pull on the belt is 400 pounds, the torque developed is $400 \times 1 = 400$ foot pounds.

(c) The unit of work is the foot pound. If we consider the time taken to do work we bring in the question of power, for power is the rate of doing work. For practical purposes, the term horsepower is used, which unit is equal to 550 foot pounds per second or 33,000 foot pounds per minute.

In the case of the electric motor, the number of foot pounds of work done by one revolution of the pulley is equal to the pull in pounds on the belt at 1 ft. radius multiplied by 2 pi, for 2 pi is the circumference in feet of a circle of 1 ft. radius. This is equivalent to saying the work done in one revolution is equal to 2 pi T where T is the torque or pounds pull at 1 ft. radius. The foot pounds of work done in one minute will equal the number of revolutions per minute multiplied by 2 pi T, hence the horsepower will be

$$\text{H. P.} = \frac{2\,\text{pi}\,T \times \text{R.P.M.}}{33000}$$

Size of Belt.—A 35 H.P. motor runs at 550 revolutions per minute and will be used to drive a line shaft pulley by a belt. What size of belt should be used?

The torque is given by:—

$$T = \frac{\text{H. P.} \times 33000}{2\,\text{pi} \times \text{R.P.M.}} = \frac{35 \times 33000}{2 \times 3.14 \times 550} =$$

foot pounds.

The torque being 324 foot pounds, by dividing the torque by the radius in feet we obtain the pull in pounds on the belt.

The radius R is 9 in. or ¾ ft.

T = 334 foot pounds.

Pounds pull = T ÷ R = 334 ÷ ¾ = 445 pounds.

Allowing a tension of 100 pounds per inch width for a good leather belt, the width of the belt will be 445 ÷ 100 = 4.45 in .or 4½ in. approximately.

Efficiency Calculation.— (a) I would like to find the efficiency of a 500 volt, 80 H.P. shunt wound, direct current motor. The ammeter reading is 135 amperes at full load and the load is fairly constant.

(b) We have a 10 H.P. 220 volt shunt wound motor on hand. Will it be possible by inserting resistance in the circuit to operate it in 500 volts?

(a) As before stated in this column the commercial efficiency is $\frac{\text{output}}{\text{input}}$, and the output at full load is 80×746 watts since there are 746 watts to a horsepower.

The input is the voltage multiplied by the current $= 500 \times 135$ watts.

Hence the efficiency full load is:

$$\frac{80 \times 746}{500 \times 135} \times 100\% = 88.5\%.$$

(b) As you suggest, the motor may be run on 500 volts providing a separate resistance is provided in series with the armature and field circuits respectively before connecting across the 500 volt line. To find the size of each resistance you will need to know the armature current and the field current; then since the voltage drop across each resistance is 500—220 = 280 volts and is the same for both, the amount of resistance is found by applying Ohm's Law:

$$\text{Fields resistance in ohms} = \frac{280 \text{ volts}}{\text{field current}}$$

$$\text{Armature resistance in ohms} = \frac{\text{armature current}}{280 \text{ volts}}$$

This arrangement should only be used when the load on the motor is constant, otherwise the variation in torque will produce unstable conditions in the machine. Of course the power lost in the resistance does no useful work and therefore this method is very inefficient.

Cost of Operating Motor.—Please advise how to figure the cost of operating any size motor, either alternating or direct curent, when the cost of power is rated in dollars per kilowatt hour.

If the horsepower and the efficiency of the motor are known, the input is found by converting the H.P. to watts and dividing by the efficiency. Thus:—

$$\text{Electrical input} = \frac{\text{H.P. developed} \times 746}{\text{efficiency}}$$

watts.

Dividing the watts by 1,000 gives the input in kilowatts, which multiplied by the rate (dollars per K.W. hr.) will obtain the cost of operating the motor in dollars per hour.

Induction Motor Starters. — What methods are used for starting squirrel cage induction motors and wound rotor induction motors?

It is customary to start small induction motors up to 5 H.P. by connecting their terminals directly to the line. But with the larger sizes the current taken in starting is excessive and some form of starting device must be used. The device most commonly used for starting motors of the squirrel cage type is the auto transformer also called the starting compensator, which reduces the starting current by cutting down the voltage applied at the stator terminals. As soon as the motor has come up to normal speed, the compensator is cut out of the circuit, and the switch thrown to running position at which the stator or primary terminals are connected directly to the line.

The wound rotor type, with its rotor terminals brought out to slip rings, has a variable starting resistance, usually a drum controller, connected across the slip rings, which reduces the heavy currents in the rotor phases at starting. When the motor comes up to speed the resistance is cut out and the short circuiting brushes again lowered on the slip rings.

FIREPROOFING BY PAINT

By O. C.

IN a sense, all painting is fireproofing; or, more properly speaking, it is fire-retarding. There are some paints made specially for fireproofing purposes, though the number of such paints is small. Most fireproofing consists in the application of some chemical solution to the raw wood that will prevent combustion; and over this paint may be applied, or, as happens in many cases, varnish or wood finish of some sort. There are many chemicals that are useful in this connection, and some are very cheap and simple. Alum is one, lime is another.

A certain master painter uses the following formula with much success: Place some fresh lump lime in a barrel, and sprinkle water over it until it crumbles into dust. Then sift it through a fine sieve, and to every 6 qt. add 1 qt. of salt and 1 gal. of water; then place on a fire and boil, skimming it occasionally. To each 5 gal. of this liquid add 1 lb. of pulverized alum, ½ lb. of pulverized copperas, and while stirring the mixture add 12 oz. potash, also 4 lb. fine clean sand. If color is desired, any pigment may be added that will not be affected by lime; any of the earth colors will do. This paint or liquid must be applied with a fibre brush, for it would injure bristles. By adding the proper coloring the effect on a wooden roof will be quite as fine as slates. It also stops leaks in the roof, if made thicker for that purpose; prevents the growth of moss by keeping the water from saturating the wood, and—the principal object—makes it impossible for the shingles to burn. This coating is also very durable.

A different but very good fireproof paint may be made as follows: Mix together one measure of clean fine sand, two measures of sifted wood ashes and three measures of powdered lime. Mix, or better still, grind in a hand mill, with raw linseed oil, or boiled oil as preferred, the latter requiring no driers, while the former does. Apply the first coat thin, let it become hard-dry; then apply the second coat, made stouter than the first.

Steam and Its Generation

ECONOMICAL USE OF FUEL URGENT

TALKING to a representative gathering of men who are to assist the Fuel Administration in the different States, at their meeting in Washington with Dr. H. A. Garfield, Van H. Manning, director of the Bureau of Mines, Department of the Interior, said concerning the necessity of urging the economical use of fuels:

"The economical use of fuel has proved to be no simple problem. The coal, the equipment, and the human variables make hard and fast general rules impossible. The Bureau of Mines has carried on extensive experiments to determine the fundamental principles of the combustion process and of furnace design, and, at the same time has been making practical application of improved practice in government power plants. Many publications are available which show the progress of the work along these lines. Americans have been as wasteful of coal as of other resources, largely because coal has been abundant. To many consumers it has seemed hardly worth while to give time and thought to the saving of coal.

"Conditions have suddenly changed. To-day it is everybody's business to save coal. Coal is the foundation stone of industry. Without it the production of equipment for war must halt. Transportation facilities must stand still. One man's careless and wasteful use may mean an idle factory or a cold house for his neighbor. With the world looking to us largely for its coal supply, with increased demands at home, with a scarcity of available labor, with overtaxed transportation facilities, the consumer of coal must pause and give serious consideration to the problem which confronts the country.

Saving Through Intelligent Consumption

"If the consumers can be aroused to an intelligent consideration of the burning of coal, they can begin to save ten per cent. of the production, (600,000,000) at once. With more effort, through instruction and a moderate remodeling of coal burning equipment, which could all be accomplished during the war, a further considerable saving can be made. The possible coal saving when present practice is compared with the best ideal practice is very large. If it were possible to supply the need of this country for light, heat, and power, through the highest type of mechanical devices, and if we could make a skilled coal user out of the average user, we could probably get along with half as much coal as we are now consuming. This ideal is far beyond present realization.

"The immediate problem is a difficult one. We cannot scrap all out of-date power plants. We must start by doing the best with what we have. We must begin saving coal at once. The problem is personal. It deals with the human element. We must reach the man with the shovel.

Household Consumption

"About fifteen million people shovel the twenty per cent. of our coal used for domestic purposes. Only about two hundred and fifty thousand firemen shovel the sixty-odd per cent. of our coal used by power plants and railroads. While we must appeal to the householder to serve coal it is vastly more important to reach the fireman through whose hands the larger part of our coal passes.

"The householder must realize that when he throws a shovelful of anthracite coal into his furnace its value is equivalent to half a pound of sugar, or half a loaf of bread, or a pint of milk. He must appreciate that it is worth while to examine his house and to overhaul his heating equipment. Weather strips, double windows, pipe coverings, clean flues and chimneys, and tight fittings in ash-pit, doors, dampers and furnace parts will all pay. Damper control is one of the chief secrets of economical heating. Clean surfaces are most essential, as soot is a poorer conductor of heat than asbestos, Care, attention, and taking pains will be the greatest factors in saving domestic coal.

The Steam Plant Fireman

"The fireman is, however, the biggest single factor to be considered in a campaign to secure the largest saving of coal. Many manufacturers have made a serious mistake in failing to consider the fireman as a skilled worker. Too often he is treated as a roustabout. He is not well instructed nor given proper labor saving devices. As coal increases in price, or becomes difficult to get, the fireman handles more and more of his employer's money. His efficiency means more in dollars and cents. This is an encouraging feature in the situation. It means a better recognition of the importance of the fireman, more efficient work on his part, and a consequent increased saving of coal. The viewpoint is changing. It is no longer cheaper to pay for the coal than to educate the firemen.

"In carrying out a campaign to promote the saving of coal, let the appeal be made to the householder to cut down his consumption in every way possible, but above all, give serious consideration to methods by which a systematic relationship may be established between the office and the fireman. Encourage the manufacturer to take a keener interest in his fuel consumption and to back up his fireman by giving him the best information and equipment available. This problem has two phases: first, to arouse the interest of the manufacturer and his engineer and fireman, and to point out the part which they can play in relieving the present crisis in coal supply; second, to furnish whatever technical instruction may be desirable and which may be immediately applicable to accomlish the result sought."

BOILER FAILURE DUE TO INCRUSTATION

THE formation of a hard boiler incrustation, consisting largely of silicates, was the apparent cause of a peculiar boiler failure, which was reported on recently in the "Chemiker Zeitung."

A series of boilers had for some years been installed in some works, and the boilers, which were in uninterrupted use, had been cleaned every three months. Under the pressure of work the cleaning had to take place at intervals of four or five months; then a crack developed in one of the boilers; the boiler was quickly repaired without much inquiry into the cause of failure, and then a second boiler failed, exactly in the corresponding spot. The boilers, which were combined with superheaters, were provided with two internal flues, which were corrugated in the front part; the cracks occurred in the straight flue near the corrugation. The examination proved that the iron was sound, but that the incrustation was locally abundant and of unusual composition.

Ten samples were taken of the deposit, which was hard in some parts and muddy near the superheater end, and which varied locally in composition to an extraordinary degree. The carbonates were always low, about 1 per cent.; the lime (CaO) percentage ranged from 1 up to 24, the magnesia (MgO) percentage from 2.7 to 25, the calcium sulphate from 2 per cent., up to 83 per cent., the silica

(SiO_2) from 9 per cent. to 59 per cent., and the percentage of iron and aluminum oxides (together) from 0.2 to 59. The iron did not come from the water, but from the boiler plates, which were corroded near the superheater end. The silica percentage was high in general, highest in the muddy portion.

The hard scale, which seemed to be responsible for the local superheating and cracking of the plates, contained 36 per cent. of SiO_2, 2.4 per cent. of iron and aluminum oxide, 20 per cent. of CaO, 8.3 per cent. of MgO, 48 per cent. of $CaSO_4$, and had also a high percentage (6) of water of hydration. The feed water came from two sources, one of which was rich in silica; such feed water is not worth chemical softening sometimes, but may be used when the boilers are frequently cleaned. A further study on silicate boiler scales is to follow.

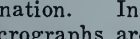
GRAPHITE LUBRICATION

IN a paper contributed to the Journal of the American Society of Mechanical Engineers, C. H. Bierbaum states that in 1913 some 30,000 tons of graphite were used for lubrication purposes. He states that both natural and artificial graphites commonly contain impurities in the shape of very hard abrasive materials, the effect of which he demonstrated by using a wooden lap fixed on the end of a high-speed shaft and coated with the graphite to be tested. On applying a glass slip to this rapidly revolving lap the scratches produced by the impurities could be easily seen on examining them through the microscope, using oblique illumination. In the paper a number of micrographs are given showing the results obtained. With thoroughly purified graphite there is no abrasion.

To obtain permanent suspension of graphite in oils or the like the particles of graphite must be less than one two-hundred-thousandth of an inch in diameter, and the oil must be free from acid or from any tendency to form acids by turning rancid. The author maintains that the use of these permanent suspensions of graphite is, however, undesirable, holding that with larger particles than are necessary for permanency of the suspension, the graphite is more effective as a lubricant. His view is that if the particles are large they will be caught and retained between the opposing surfaces of a bearing, should these approach near to each other owing to a failure of the oil film; whilst under similar conditions he asserts particles of the size necessary for forming a permanent colloidal suspension of the graphite would prove ineffective. The point, however, is obviously one to be settled by actual practical experience and not on a purely theoretical basis, and users of these colloidal suspensions do make the claim that, whatever the mechanism at work, their lubricated surfaces do, as a matter of fact, get loaded with graphite, notwithstanding the smallness of the particles.

STEAM VERSUS DIESEL

AN American sea-going engineer with first-hand knowledge of the service of both types says that while the modern steam engine is a wonderful machine, the Diesel motor is still more wonderful. The manual labor of handling the fuel is done away with altogether. Once the motor is started the fuel supply is kept up by pumps on the engine itself, delivered to the filter and from there to the cylinders, where combustion takes place. After it has done its work in the cylinders it passes off as waste gas to the atmosphere. All this takes place without manual labor, and to the engineer who has been with steam engines and then takes up the Diesel, the change appeals most forcibly, for with the machine developing its power within itself all that is necessary is the occasional manipulation of a valve. It is true, this engineer admits, that the Diesel has not yet reached the state of perfection at which the reciprocating steam engine has arrived, but considering the shortness of the time it has been employed in marine work, that could hardly be expected. There is not the slightest doubt, however, that in a few years' time it will be, in respect of reliability, in advance of the steam engine. At present there are motorships crossing the Atlantic with as great regularity as steamships, keeping as good, if not better, time, and coming through the heavy weather without a hitch. "I have," the writer declares, "spent a good few years on the Atlantic, and I would rather be with a Diesel engine in heavy weather than with a steam job."—Syren and Shipping.



REGARDING PACKINGS, WORN THREADS AND OTHER ENGINE ROOM PROBLEMS

By J. M.

IN the general attempt to keep down engine room expenses, there has been considerable temptation to engineers to, for some purposes, save their higher priced packings and use lower priced materials of a different kind instead. In the lower pressures this is quite feasible so far as packing for flanges, cylinder heads, low pressure pumps are concerned, but for piston rods, mudports and manholes, I, for one, do not favor this low-priced material. Incidentally, I might mention an instance that came to my notice some years ago, where the use of unsuitable materials as a substitute for the "dollar a pound" patent piston packing formerly used resulted in so cutting and scoring the rod and in producing undue friction as to many times more than offset the difference in cost of material used. The loss was really due to the new supply of proper packing not being on hand until some time after the old supply had been exhausted, rather than by intentional experiment on the part of the attendant. Speaking first of plants using the lower pressures, say 80 pounds and under. In one of these equipments the only packing that has been used on the cylinder heads during the last few years has been candle wicking, bought then at ten cents per ball. The method of procedure is: Remove the cylinder head and around the portion of it which normally projects into the cylinder, wind two laps of the wicking close together and close to the shoulder, then wind a third lap on top of these two, taking care not to wind it so tight as to spread the first two laps, thus drawing the third one down between them. The wicking is cut long enough that one end can be passed out through one bolt hole of the cover and the other end carried so as to give a little more than the exact three laps and then pass out through another bolt hole. This holds the ends in position while the head is being returned to place. The threads of the bolts, if they touch the wicking are more inclined to abrade it than to pull it out of place. When drawn up tight this packing does not take up much space and therefore does not materially increase the clearance space. As stated before, it is O.K. for pressures of 80 lbs. or less. This method has been used successfully on an engine fed from a boiler carrying over a hundred pounds pressure. For flanges and for covers of rectangular steamchests, I have found asbestos board both cheap and serviceable. Sheets one-sixteenth of an inch thick are suitable if the joint surfaces are smooth, but pitted or corroded joints may require two ply of this, or one ply of eighth inch board. Asbestos yarn is another material in considerable favor by a few engineers. My first acquaintance with this kink was when calling on a friend some years ago. He told me he had packed the steamchest cover just a few days before and used only asbestos yarn, putting one lap around inside (I think he said inside) of the bolts, and afterwards winding a short piece around each bolt. He used one piece to each bolt and each piece around its bolt once. There was no sign of a leak at the time of my visit, and if I remember rightly, he was carrying something over a hundred pounds pressure on his boiler. The outfit was a comparatively small one, but the said steamchest cover would measure at least 15 x 20 in., and I think 18 x 24 is more nearly its real dimension, consequently the saving in sheet packing was noticeable. My next lesson in this line came about seven years ago. I went over to the machine shop to get a couple of stud bolts made and meanwhile the engineer in charge packed one of the steamchest covers with the asbestos yarn, placing it inside the bolts and lapping the bolts with short pieces as mentioned above. The pressure carried on the boiler was 110 lbs. That joint gave no further trouble that season, and I have questioned the men in charge since, and so far have not learned of that particular joint having ever been packed since. The outfit, however, seldom ran more than six or seven months in each year. After seeing these two successful applications of the scheme I tried asbestos yarn myself, but prefer the asbestos board instead, as I general-

(Continued on page 329.)

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Vol. X. NOVEMBER, 1917 No. 11

PRINCIPAL CONTENTS

C.P.R. Quebec Terminal Power House Equipment 305-307
General 307-308
New Electric Locomotive....Iron Weapons of the Aztecs.
Comparison of Working Costs of Principal Prime Movers.....309-312
General 312
The March of Progress.
Duty Trials on Two 24-Million-Gallon Pumping Units.....213-316
Modern Steam Power Plant and Its Appliances—I.....317-318
General 318
The Effect of Spellerizing on the Life of Steel Tube.
Electricity and Hydraulics 319-321
World's Most Powerful Locomotive....Electric Power Generated by Earth's Heat....Sulphur from Gas Engines and Electrical Equipment....Motive Power in Norway....Transmission Line Protection....Technical Notes.
Steam and Its Generation 322-323
Economical Use of Fuel Urgent....Boiler Failure Due to Incrustation....Graphite Lubrication....Steam versus Diesel ....Regarding Packings, etc.
Editorial 324
Five Talents or One.
The Operators' Point of View 325-329
Does a Piston Stop at Reversal?....Things Anybody Can Do....Capacity of Cylindrical Tanks....Is White-painted Pipe Covering More Efficient Than Black?....Wire Clamp Machine....A Water Level Gauge....A Fusible Plug for Boilers....Siphoning Gasoline and Similar Liquids.
Selected Market Quotations (Advtg. Section)..... 44
Trade Gossip, Catalogues 46

FIVE TALENTS OR ONE?

DURING the early months of war, many students of historical events drew inspiration from the saying that "history repeats itself," and on every hand one heard forecast after forecast which were all in turn completely upset as each phase of Armageddon unfolded itself to the world's inhabitants. At least one parallel drawn by a writer has been justified by the course of events. He drew attention to the fact, and it has not so far been contradicted, that at the close of the Napoleonic wars, the world was really more civilized, judged from the standpoint of intellectual knowledge and industrial achievement than it was at the beginning of those troublous times. Numerous advances in the arts and sciences, manufacturing developments, and political economy took place, which marked great progress at the time and formed a solid foundation for that phenomenal development of the British nation, the envy of which is not the least of the present war's causes.

Now that the threatened avalanche of militarism has been definitely averted, and seems in a fair way of being rendered harmless, the strain of recent events has found expression in many ways, not the least valuable of which is that of "self-search" as typified by some recently published books by authoritative writers. We refer specifically to the book "Eclipse or Empire," by H. B. Gray and S. Turner. The theme of this book is the subserviency of everything to the industrial national aspect. Extracts received from an English contemporary indicate the exceedingly chastened spirit in which the authors view the industrial placidity of the British nation during the past two or three decades. They state "that during the last twenty to forty years most of the inventions, new ideas and developments have been given to the world by countries other than our own; furthermore, that their value has been more quickly appreciated and put to practical use in foreign lands." As our authority expresses it, "the book, condensed to the point of extreme brevity, is a valuable resumé of alleged national shortcomings, and should be in the hands of every engineer; indeed, just such a compilation, cataloguing and digesting for easy reference a survey of the entire industrial field from one viewpoint was badly needed.

The burden of the foregoing remarks in their bearing on our past, present and future development is sufficiently obvious. We were not able, nor did circumstances give us the opportunity, to benefit industrially, at the time, by events of a hundred years ago, but now every force at the service of mankind is directly engaged in military, industrial and scientific activity, the results of which are, so to speak, immediately at our disposal.

True, the return of peace will see the re-entrance of our present enemies, under due limitations no doubt, into the world's industrial arena, but what of the present? Is the cessation of hostilities to find us where we were at the start? Shall we lack interest for the present, and avoid effort in the future to avail ourselves of the world's advance marked in years instead of decades or centuries as formerly? Amidst the wealth of information being spread almost daily, are we to find no atoms which we may retain and benefit thereby? Shall our record in the present forceful era be one of assimilation only, or one of forceful origination. The future alone can tell, but the making of the answer is in the hands of our manufacturers now. They are in the position of the talent receivers—the point is whether they wish to be known as the man who received five talents and doubled them, or the man who received one—and "hung on to it."

To quote from the work which prompts these remarks "It matters but little what a man is to-day—the great matter is what he desires and intends to be in one, or two, or three years' time. He is not a mere machine with two hands and two feet—but a living pulsating energy. He has a trinity of powers—spirit, mind and hand, and the least of these three is hand. For it is only the spirit to do, and the mind to create, that can make the hand move at all. . . . The progress of our nation will depend on the rate at which we turn the principles and theories of science into terms of ascertained facts."

The Operators' Point of View

DOES A PISTON STOP AT REVERSAL?

AS a connecting rod is not of "infinite length," I think Mr. Miller's argument falls down from the fact that, to arrive at his conclusion, he has to introduce a proposition that is impossible. The piston travels fastest as the crank is at right angles with the piston and slows down as it approaches the direct horizontal, and again is accelerated as the opposite angle is approached. At the centre as the piston reverses its motion it must stop to make the return trip.

Also, if therefore the speed of the piston varies during each stroke, while the flywheel is in constant and uniform motion, it is not beyond the possible that at the moment of reverse motion the piston could and does stop.

W. K. MACLEOD.

Chilliwack, B.C.

HAVE read with interest Mr. Schaphorst's article under above caption. I have heard this subject argued many times and it recalls an incident that happened some years ago. The local freight had pulled into the depot. The engineer was a man who would accept no signal not properly and clearly given. It was desired to spot a certain car for unloading at the freight shed and the engineer was moving ahead slowly on the brakeman's signal. The brakeman, engaged in conversation with the station agent, allowed the car to pass the spot where it was desired to have it stop and seeing his error gave the signal to back up, but the engineer continued to move ahead. The brakeman then ran ahead and demanded why the engineer was still moving ahead and the reply was coolly given. "In order to back up I must first have a signal to stop as I cannot back up while going ahead without stopping first." This seems to be a single answer to the crosshead and piston problem.

Is not also the crosshead somewhat analogous to the alternating electric current sine wave. Using the clock diagram for the development of the sine curve the e.m.f. begins at zero, rises to maximum value at 90 deg., falls again to zero, rises again to maximum value in the opposite direction at 270 deg., and falls again to zero, thus completing one cycle, or, in the case of the crosshead, one forward and one backward stroke completing a revolution of the shaft.

W.C.S.

St. Thomas, Ont.

THINGS ANYBODY CAN DO?

By D. A. Hampson.

BUILDING a fire in the forge and dressing an emery wheel! Anybody can do those things, you say—and yet if you come right down to the fine point, few mechanics can do these homely but important tasks well.

Building the Forge Fire

While any man can build a fire of some sort, not every one can build a forge fire in a room occupied by other workmen without almost smoking them out. Following the few simple rules will make this easy. To begin with, scoop out the coal over the tuyers down to the lining of the forge or to the pan itself if it is unlined, making a pocket that will just about hold a double handful of shavings. More shavings than this are unnecessary. If shavings are not available, use excelsior wadded into about the same size. Waste will do in a pinch, but is open to several objections, principal of which are the odor from burning, greasy cotton, and the loss of expensive material, for in these days it pays to have waste washed.

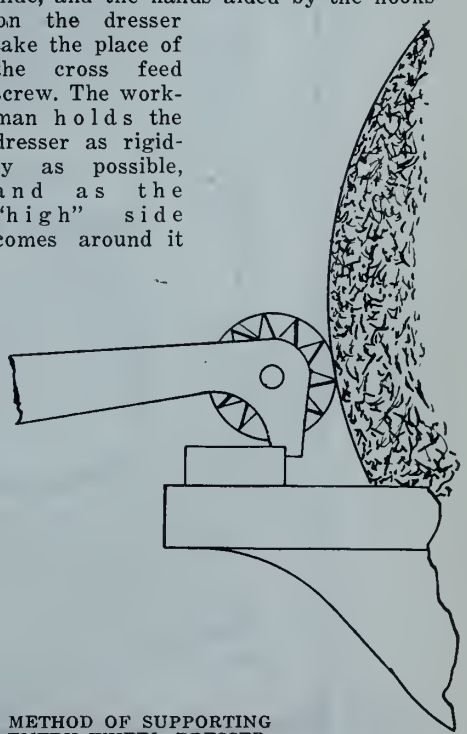
The pocket made in the dead coal is better than scraping the coal all away, for it starts the fire in compact form and prevents many a lost start. As soon as the shavings are lighted, begin to throw on pieces of coal that have once burned—not fresh coal or clinkers—and turn on the blast gently. If the blast is started too hard, the shavings will burn so quickly that the coal does not get a chance to ignite; what is wanted is just enough air to keep the fire going and furnish free, smokeless combustion for the shavings, but at the same time, to burn slow enough to give the coal a chance to "catch." Following the flame with a light covering of coal—not too much in the middle—will produce in less time than it takes to tell it, a small but live fire that may be enlarged if it is so desired. And the best part of it is that the trick could be turned in your own parlor without creating any smoke that you could notice.

Dressing the Emery Wheel

It is hard to impress upon the minds of many mechanics the fact that the wheel on which they sharpen their tools must in turn be sharpened and have the nicks taken out of it. Not many jobbing shops possess a diamond, but they all have one or more emery wheel dressers around somewhere, that use fluted or star wheels, or cutters. These wheels present a broken area of contact to the emery wheel or grindstone and as they revolve with the latter, they cannot slide along and fill or glaze as does the work being ground. As they revolve, the hardened points cut or break up the surface of the grinding wheel, thus exposing new, sharp grains for working. A few passes across a grindstone or emery wheel will do this sharpening.

But through the carelessness of workmen the face of grinding wheels gets grooved and dug up, and, worse still, they get flat spots worn on them producing what appears like a wheel out of round. To restore the wheel to a round again requires something more than following across with the dresser. The high side must be turned off and the process is similar to a like job in the lathe, but the tools used are the dresser and the work rest of the machine; in case the latter is of odd shape, a bar of steel and two C-clamps will answer.

The drawing shows how the work is done. The dresser is the cutting tool, the bar of steel corresponds to the cross slide, and the hands aided by the hooks on the dresser take the place of the cross feed screw. The workman holds the dresser as rigidly as possible, and as the "high" side comes around it



METHOD OF SUPPORTING EMERY WHEEL DRESSER.

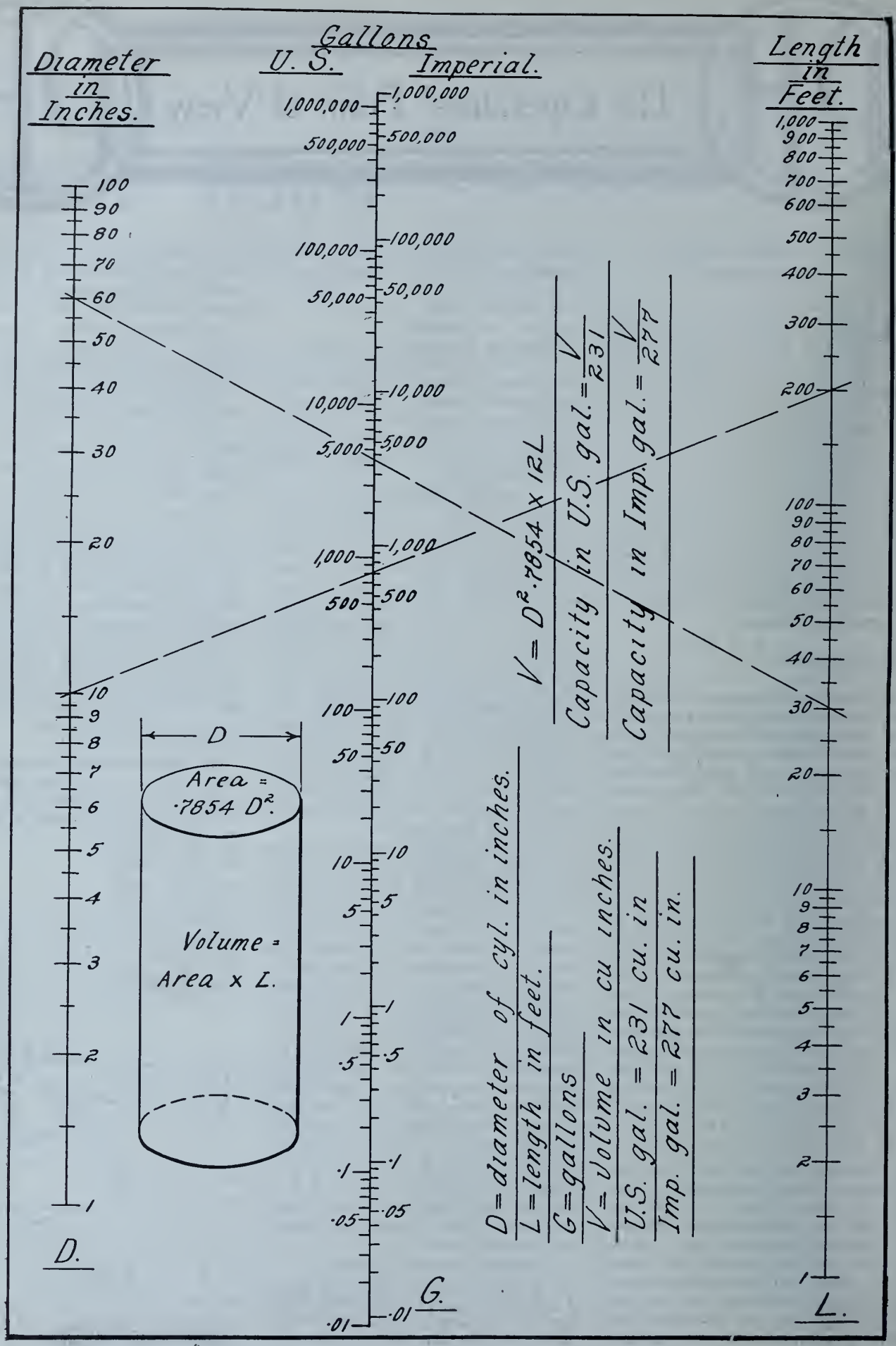


CHART OF CYLINDRICAL TANK CAPACITIES.

is cut down, each revolution taking a little more. In doing this, the work is started on that part of the wheel that is largest in diameter and a cross movement imparted to the dresser so it doesn't cut grooves in the wheel just as would a piece of work held in one place. Keeping up this cross movement with the handle of the dresser held fixedly in one place and gradually raising it, will cut the stone down to a true cylinder. But it takes care and it couldn't be done except from the steadying provided by the hooks on the dresser.

CAPACITY OF CYLINDRICAL TANKS

CALCULATIONS for the capacity of cylindrical vessels are often tedious work to those not very familiar with the method by which these results are attained. While many handbooks can be had that give the tables for the various capacities for certain diameters, it is invariably the case that the time occupied in securing the desired information is greater than would be required to figure it out. It is well, therefore, to learn the principle by which these mental problems are solved. Generally speaking the capacity of a vessel is computed in gallons, while the dimensions are invariably given in feet or inches, and it is, therefore, necessary to determine the volume of the interior and find the corresponding capacity for such a volume. The volume of a cylindrical vessel is found by multiplying the area of the base by the length or height. The area is .7854 times the square of the diameter; for instance, it is desired to find the volume of a cylindrical tank 15 feet in diameter and one foot deep. The area of the base would be $.7854 \times D^2 = .7854 \times 15 \times 15 = 176.7$ sq. ft., and one foot in height would give a volume of 176.7 cu. ft. One cubic foot of water contains 6.23 Imperial gallons or 7.48 U.S. gallons; therefore the capacity of the above tank in Imperial gallons would be $6.23 \times 176.7 = 1100.8$ Imp. gallons. In United States measure the capacity would be $7.48 \times 176.7 = 1321.716$ U.S. gal. In smaller tanks where the diameter is usually given in inches and the respective volumes of an Imperial and U.S. gallon are 277 and 231 cu. inches, it is customary to use these latter values in calculations.

A cylindrical tank 60 inches in diameter and 30 feet long would have a volume of $.7854 \times D^2 \times L = .7854 \times 60 \times 60 \times 30 \times 12 = 1{,}017{,}878$ cubic inches. The capacity in English measure would be $1{,}017{,}878 \div 277 = 3674$ Imp. gal. In U.S. gal. the capacity would be $1{,}017{,}878 \div 231 = 4406$ gal.

To convert Imperial gallons to United States gallons multiply by 1.2; thus, in the above example $3674 \times 1.2 = 4408$ U.S. gal. To convert U.S. to Imperial multiply by .833.

$4406 \times .833 = 3671$ Imp gal. The small differences in the values result from the slight error in decreasing the number of decimal places in the constants 1.2 and .833. These constants are derived from dividing the respective volumes by each other; as 277 divided by 231 gives 1.199, and 231 divided by 277 gives .833.

It is often possible that an approximate value is sufficiently accurate for tank capacities, and for this purpose the accompanying chart will be found of great service. On the graduated scale D, to the left, are given the various diameters of tanks in inches, and in the right-hand column L the length in feet. A straight line drawn from any two points on the two outer scales will interest the middle column G at the approximate capacity in U.S. and Imperial gallons.

IS WHITE PAINTED PIPE COVERING MORE EFFICIENT THAN BLACK?

By A. H. W.

THE consulting engineer of the plant of which I have charge tells me that by painting the pipe covering dark I lose a great deal more heat than I would had I left them white. He also says that stove pipes which have been painted white will not let any heat out in the room, whereas, if they are painted black, they will let out considerable heat.

An explanation of these points will be much appreciated by the writer.

The fact that a perfectly black body will absorb more heat than a lighter colored body must be accepted as a phenomenon which we cannot definitely explain. We unconsciously apply this knowledge in everyday life by donning light colored apparel for summer rather than dark, the better to shed the heat of the sun's rays.

This relation between the heat absorbing power of a body and its power to reflect light is accounted for by considering both light and heat as a form of radiant energy, differing in the way in which they affect our physical senses. We see a body by reason of light reflected from that body to the eye. Were it possible to find a body which would absorb all light and reflect none, it would appear perfectly black. Again, we are sensible to the heat of a body by reason of heat reflected from the body. A perfect absorber of heat would reflect no heat radiation.

It so happens that bodies which have the properties of absorbing light most readily are also the best absorbers of heat so that a perfectly black body has the highest heat absorbing power. Conversely those bodies which are the best reflectors of light have the least heat absorbing power. The same applying relatively to all intermediate conditions between light and darkness.

Although no such perfectly black body is known, yet a surface coated with lamp black absorbs such a large proportion of heat and light radiation as to sufficiently fill the condition for practical purposes. Taking the heat absorbing power of lamp black as 100%, it has been found experimentally that the relative heat absorbing power of white lead is about 20%, with that of burnished silver the lowest at 7%. It would be interesting in this connection to know the value for aluminum paint which is sometimes used on stove pipes, but no figures for this are available.

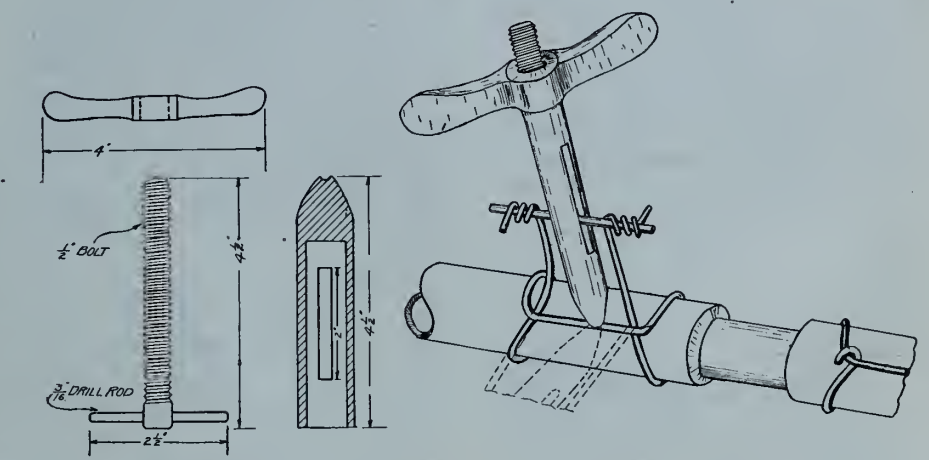
However, this should answer your query as to the possibility of preventing in some degree the loss of heat by painting the radiating surfaces white, though the ideal condition referred to in your letter will hardly be attained.

WIRE CLAMP MACHINE

By Sam E. Burd.

OWING to the large number of hoses in use at our plant, I devised the machine shown in the sketch to save time and clamps, and I find it will hold nipples, etc., better or as good as bought clamps, and it is a lot faster.

I use annealed wire ⅛ in. in diameter, wrap it about the joint as shown, set the nose of the tool against the wire as shown, wind the loose ends around the pin and screw up tail nut. When tight, throw machine so as to make a hitch on the wire and cut.



DETAILS AND ARRANGEMENT OF WIRE CLAMPING DEVICE.

A WATER LEVEL GAUGE

By J. E. McCormack.

I HAVE worked in several small mills built for ore crushing and washing. Tanks were always provided at a point higher than the jigs, vibrators, etc.,

using the water. The pump man was warned by whistle signals when the tank was nearly full or nearly empty. I have had to depend on unsatisfactory floating tank gauges until I became disgusted with such contrivances. Now, however, until someone shows me a better gauge, as easily constructed and as visible for

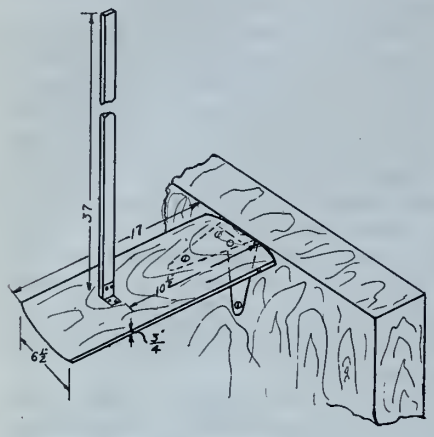


FIG. 1.

reading from a distance as is the one described below, I shall choose it for use in such plants whenever my personal convenience is involved.

The float shown in Figs. 1 and 2 is a piece from the centre of a thick barrel head. Its dimensions are: Thickness, ¾ in.; extreme length, 17 in.; width, 6½ in. The upright piece is 1 in. wide, ½ in. thick, and 37 in. long, and is placed at right angles to the float, with its 1 in. way parallel with the long way of the float. The centre of its secured end is 10½ in. away from the end of the float to which the hinge is attached. The hinge used is 13 in. long when open, has the joint midway of its length, and is 2¼ in. wide at the joint. Referring to Figs. 3 and 4, with the water level 7 in. below the joint of the hinge the top of the upright piece rests on the edge of the tank, but with the water level 4½ in. below the joint of the hinge the upright piece assumes an almost vertical position and is, therefore, visible for some distance.

In tanks 3 to 5 ft. deep (and quite pos-

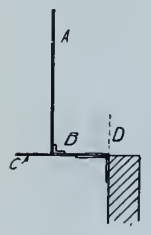


FIG. 2.

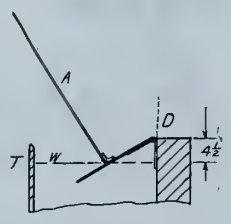


FIG. 3.

sibly in deeper ones also) a larger float with a longer upright piece and placed nearer the bottom gives visible warning when the water has fallen below the predetermined point for which it was set. This lower float must have its upright located by experiment owing to the action of the water on it.

Small differently-colored flags attached to each upright increase the distance from which the gauges may be read. Bell circuit push buttons may be located when these uprights may come against them and give audible warning in the engine room if desired, but this is not necessary unless the view is obstructed. These gauges are sufficient where the pump man is warned by whistle, as in construction work and ore crushing mills, etc.; and if the hinge is a free working one, the device does not cramp, bind or stick, nor get out of place, as did various devices previously tried out.

A FUSIBLE PLUG FOR BOILERS

By James E. Noble.

WHEN given reasonable attention the fusible plug is an important safety device. When the filling becomes covered with scale its usefulness as a safety device is nil; therefore, it should be cleaned off frequently.

Banca tin makes a reliable filler, but no filler will remain in its virgin condition very long when installed in a working steam boiler. It should be refilled with fresh tin about twice a year.

When careless attendants are in charge the fusible plug is apt to be neglected and its usefulness destroyed, but if it is in anything like fair condition it will protect the boiler from the carelessness of an attendant who may allow the water to reach a dangerously low level. The attention of the operator will be directed to the racket kicked up by the escaping steam and the necessity of emptying the boiler to instal another plug.

The manager, chief, or owner should personally see that a proper filling is put in, for many cases are on record where the attendant has refilled a plug with an iron core instead of a tin one.

On return tubular boilers the plug is usually placed two or three inches above the top row of tubes in the back head. A coating of graphite is usually placed upon the plug thread before inserting it into position, so that it can be removed at any future time with ease.

The sketch illustrates how one engineer installed fusible plugs with what

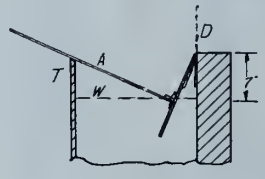
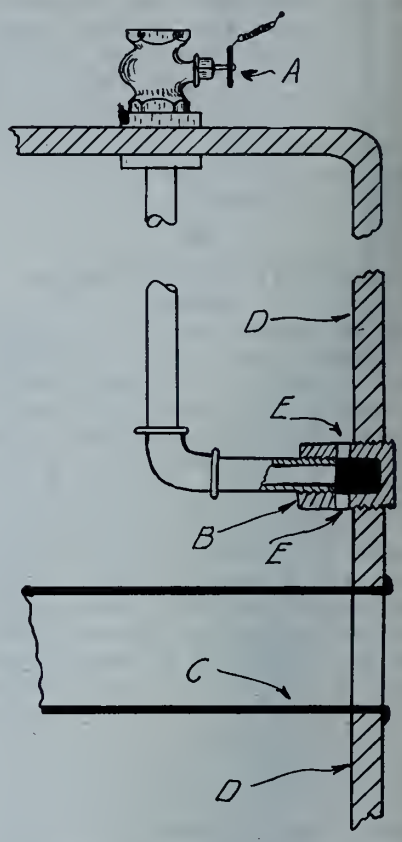


FIG. 4.

he claimed satisfactory results. His idea was to have the plug so inserted that he would not have to shut down if one melted out.

The hollow cap B was screwed into the tube sheet D. The cap was filled with Banca tin and there were openings into the steam space at E E. C is one of the boiler tubes. If the plug melted it would run out at E and steam would blow from the valve A, to which a small steam whistle was attached.

This called attention to the danger, and if the water was not below the col-



FUSIBLE PLUG ATTACHMENT.

umn, the cock could be closed until evening, when the boiler could be blown down and a new plug inserted.

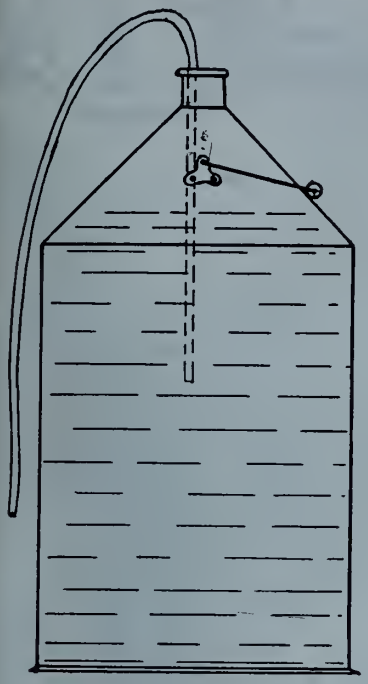
SIPHONING GASOLINE AND SIMILAR LIQUIDS

By J. M., Haliburton

ATTEMPTING to pour from a full can of the five gallon type and finding it very difficult to obtain an even flow without the liquid running down the side and dripping on to the floor, I took a piece of rubber tubing (a piece of any small pliable airtight hose may be used) and holding it by extreme end as in sketch, lowered it into the can as far as convenient, and after allowing it to remain a moment to insure its filling properly, placed my finger over the exposed end and withdrew the tubing sufficiently to allow its outer end to hang below the surface level of the contents of the can, when, upon removal of my finger from the end of the tube, I obtained a satisfactory siphon action, and have frequently used the device since with excellent results.

To change the stream to a second vessel the flow may be momentarily stopped by again placing the index finger over the end of the tubing, or better yet, if the tubing is soft enough it may be closed by squeezing between the thumb and finger.

A suitable strainer may be added to the inner end if desired and with a long enough piece of tubing the vessel, if in an elevated position, may be nearly emptied with this device alone, but in this case if the liquid is low in the can it is better when withdrawing to squeeze the tubing shut between its dry and its



SHOWING TUBE IN ACTION.

wetted portion thus guarding against the entrapping of the air which is in its unsubmerged portion as this might impair the efficiency of the siphon.

The method affords an easy way to draw off a little gasoline from the auto tank when required for priming or other purposes and is more pleasant than starting the siphon by drawing the gaso-

STARTING SIPHON PIPE.

line through with one's breath as I have seen done.

For tubing I have used ⅜-in. eclipse tubing with success where coal oil or gasoline were the liquids involved.

EFFICIENCY TEST ON WATER-TUBE BOILER FITTED WITH MECHANICAL STOKERS

THE following data were obtained during a recent test on a 600 horse-power water-tube boiler of the Heine type fitted with Galt sprinkler stokers:

General.	
1—Duration	8 hours
2—Heating surface of boiler (Heine—600 H.P.)	6,000 sq. ft.
3—Method of firing	Galt Sprinkler Stoker
4—Area of grate	108 sq. ft.
5—Ratio of heating to grate surface	55.5 to 1
Fuel.	
6—Kind used	(Screenings), 2 parts anthracite to 1 part bituminous
7—Calorific value of fuel as fired	
8—Calorific value of dry fuel	12,500 B.T.U.
9—Percentage of moisture	5%
10—Thickness of fire	3½"
11—Ttotal coal fired (wet)	18,600 lbs.
12—Total coal fired (dry)	17,670 lbs.
13—Coal consumed per hour	2,325 lbs.
14—Coal consumed per square feet of grate per hour	21.5 lbs.
15—Ash, clinker and refuse	2,120 lbs.
16—Percentage of ash, etc., to coal burned	12.4%
17—Total combustible	16,964 lbs.
Steam.	
18—Average pressure by gauge	120 lbs.
19—Saturated steam temperature	350°
Water.	
20—Total evaporated at 162°	151,020 lbs.
21—Evaporated per hour at 162°	18,876 lbs.
22—Total evaporated from and at 212°	166,517 lbs.
23—Evaporated per hour from and at 212°	20,689 lbs.
24—Evaporated per sq. ft. of heating surface per hour at 212°	3.4 lbs.
25—Evaporated per lb. of coal as fired at 162°	8.19 lbs.
26—Evaporated per lb. of dry coal at 162°	8.54 lbs.
27—Evaporated per lb. of coal as fired from and at 212°	8.95 lbs.
28—Evaporated per lb. of dry coal from and at 212°	9.42 lbs.
29—Evaporated per lb. of combustible at 162°	8.9 lbs.
30—Evaporated per lb. of combustible from and at 212°	9.81 lbs.
31—Factor of evaporation	1.096
Draught.	
32—Under grate forced.	
Temperature.	
33—Feed water	162°
Efficiency.	
32—Efficiency of boiler, furnace and grate (100 x item 28 x 970.4) / item 8	73.12%
33—Efficiency of boiler and furnace— (100 x item 30 x 970.4) / Calorific value of 1 lb. combustible.	
Average boiler rating developed per hour	600 H.P.
34—Ten sq. ft. of heating surface—1 H.P.	
34.5 lbs. of water evaporated into steam at 212°—1 H.P.	

REGARDING PACKINGS AND WORN THREADS

(Continued from page 323.)

ly find it more easy to hold in place while putting the joint together again. I have known both tallowed candle wicking and asbestos yarn to each be recommended for packing valve stems. I have tried both. Once with each was enough for me. The one was too hard, and the other wore too quickly. I have tried hemp packing for these and like it better, though I would advocate it because of its cheapness rather than because of exceptional virtues for the purpose mentioned. I use oil on it, as this is more convenient than tallow, and, according to my experience, less apt to produce verdigris. One man got fifteen cents worth of this some eight or more years ago. He has been back and forth between two plants using engines 10 x 12 and 11 x 16 respectively, and using from this for the globe valves in both plants. Last autumn he had a little of it left yet. So far as small outlay for packing is concerned, I believe that the said candle wicking, asbestos yarn or asbestos board and the hemp packing provide an easy means to that end, so far as the cylinder heads, steam-chest covers, pipe flanges and globe valves are concerned. I also believe these to be both feasible and satisfactory in plants working at eighty or less lbs. per sq. in. I know that they can also be used for pressures up to 120 lbs., but let us consider another feature in connection therewith. When using those "gol darned patent packings at one or two dollars a pound," we can put the nuts up to a reasonable strain, then after turning on just a little steam for a while and getting the iron heated through, we can tighten up some more, until finally we have a tight and reliable joint without unduly straining the bolts. On the other hand, if we use low priced, less pliable materials, we must perforce put a greater strain on the bolts to make the material imbed itself into any irregularities in the metal surfaces and in order to hold it in place against the pressure of the steam. This excessive strain, on the bolts means ultimate premature stripping of the threads, and this in turn means either increased depreciation or increased repair costs, whichever way you prefer to figure it. This may easily overbalance any first cost saving made by using the cheaper material in plants using these higher degrees of pressure. It is in heating plants and in those power plants which have had the working pressure materially reduced owing to the advent of the new boiler laws that candle wicking, asbestos and hemp, can perhaps be used to advantage.

Delta, B.C.—The council is considering the installation of an electric pump and pump-house in East Delta. Estimated cost, $12,000.

Operators' Instruction Course

Question.—Why is a vacuum measured in inches?

Answer.—It is customary to speak of a vacuum in terms of inches of mercury instead of lbs. per sq. in. simply because the most convenient and accurate method we have of measuring a vacuum is the mercury tube. It could be measured in feet of water if desired but in this case the gauge would have to be over 30 ft. long. When an ordinary pressure gauge is used to measure vacua, it may be calibrated in lbs. per sq. in. or inches of mercury, but such gauges are always calibrated against a mercury tube as a standard. In a barometer the average height of the mercury column is 30 inches and as mercury weighs 0.49 lbs. per cu. in., this column represents a pressure of .49 multiplied by 30 or 14.7 per sq. in atmospheric pressure. Thus, if the barometer stood 30 in., a vacuum of 26 in. would mean there is an absolute pressure of 4 in. or 4 x .49 lbs. per sq. inch.

* * *

Question.—(1) What is the difference between a Fahrenheit thermometer and a Centigrade thermometer? (2) How do you change from degrees Fah. to degrees Cent?

Answer.—(1) On the Fahrenheit scale the boiling point is marked 212 deg. and the freezing point 32 deg. and the interval between these fixed points is divided into 180 deg. Zero on this scale will be 32 deg. below freezing point. The Centigrade scale has its freezing point marked zero and its boiling point marked 100 deg.

Since 100 Centigrade degrees cover the same range of temperature as 180 Fahrenheit degrees, one centigrade degree is 180-100 or 1 4-5 times as long as one Fahrenheit degree.

(2) In converting temperatures from Fahrenheit to Centigrade or vice versa confusion may be avoided by referring to the temperature as being so many degrees above or below the freezing point of water, which on the Centigrade scale is marked 0 deg. and on the Fahrenheit 32 deg. Thus 60 deg. F. is 28 Fahrenheit degrees above the freezing point and equivalent to 22 x 5-9= 15.5 Centigrade degrees above the freezing point. The given temperature 60 deg. F. then corresponds with 15.5 deg. C.

Conversely, 10 deg. C. is 10 Centigrade degrees above freezing point equivalent to 10x9-5=18 Fahrenheit degrees above the freezing point or corresponds to a total Fahrenheit reading of 18+32=50 deg. F. A temperature of —15 deg. F. is 15+32=47 Fahrenheit degrees below the freezing point, equivalent to 47x5-9 =26.1 Centigrade degrees below the freezing point or —26.1 deg. C.

* * *

Question.—We have been using a single stage double suction centrifugal pump, direct connected to a direct current shunt wound motor, to pump water from a well to a tank mounted on a power. Recently we connected up to draw water from the city mains, but now the motor seems to be working under a heavier load than before. Why is this? Would not the city water pressure help to reduce the load on the motor ?

Answer.—The effect of such a change would be to increase the load on the motor by causing it to raise a larger volume of water in a given time, consequently the tank will be filled in a shorter time than before. Keeping in mind the characteristics of the centrifugal pump, that the pressure generated depends entirely on the speed of the pump and for any constant speed the amount of water delivered will be smaller when working against high pressures than when working against low pressures, it is evident that any condition tending to reduce the pressure at which the pump is working will increase the amount of water pumped and therefore the work done by the motor.

While you fail to state the head worked against we can assume from the description of the installation that the presure worked against is not over 150-foot head and that generated by the pump equal to 200 foot head. Then when working alone there was a net pressure corresponding to a 50-foot head for pushing the water through the pipe, while when working from the city mains, with a pressure say of 50-foot head, there was (200 + 50)—150=100-foot head net pressure which, of course, sent more water through the pipes and gave the motor a proportionately greater amount of work to do.

* * *

Question.—Is there any way of finding the brush polarity on a generator without using a voltmeter?

Answer.—If the generator is supplying electric current to a circuit, about the simplest way to determine the polarity is by means of the compass. Hold the compass over one wire of the circuit and arrange the wire parallel with the compass needle with no current flowing. If, when the current is flowing, the north pole of the compass is deflected to the east, the direction of current is towards the north. If deflected towards the west the current is flowing southwards.

When the generator is not connected in the circuit, a good method is to hold a wire from each terminal a short distance apart in salt water when bubbles will arise from the negative terminal. Care should be taken not to touch the wires together and with the higher voltages to keep them well separated as a short circuit on circuits of 100 volts and over is likely to cause bad burns.

* * *

Question.—A refrigerating room 15 x 30 x 8 ft. high is required to chill 5 tons of meat per day from 80 deg. to 34 deg. F. Provision must be made for 2 16-c.p. inc. lamps and one man working in the room for 8 hours each day as well as one complete change of air per day. The insulation is a 16-inch brick wall and 2 inches of cork.

Answer.—The average specific heat of meat is about 0.75. The amount of heat to be extracted to lower 10,000 pounds from 80 deg. to 34 deg. is 10,000 × (80 —34) × .75 = 10,000 × 46 × .75 = 345,000 B.t.u. (1).

Quantity of air to be cooled is 15 x 30 x 8 = 3600 cubic feet or about 3.6 × 73.1 = 263.1 pounds (73.1 pounds per 1000 cu. ft.). Specific heat is 0.237. Heat to be withdrawn in cooling 263.1 pounds of air from 70 deg. to 34 deg. = 263.1 × .237 × 36 = 2,244.7 B.t.u. (2).

Area of walls = (2 x 30 x 8) + (2 x 15 x 8) + 2 x 15 x 30 = 480+240 + 900 = 1620 sq. ft. With the insulation mentioned the loss of heat is 2.75 B.t.u. per sq. ft. per 24 hours per degree difference between outside and inside temperature. Assuming outside temperature to be 70 deg., the heat loss by radiation is, 1620 × 2.75 × 36 = 160,380 B.t.u. (3).

Two lights require 3.5 × 2 × 16 = 112 watts. Heat per minute = 112 × .0568 = 6.36 B.t.u. per minute or 6.36 × 60 × 8 = 3,019.4 B.t.u. per day (4).

A workman will radiate about 500 B.t.u. per hour or 500 × 8 = 4000 B.t.u. per day. (5).

The sum of these five results represents the total heat to be removed, which equals 345,000 + 2,244.7 + 160,380 + 3,019.4 + 4,000 = 514,644.1 B.t.u. per day. This is equal to $\frac{514,644.1}{288,000}$ = 1.787 tons of refrigeration.

A CONTRAST

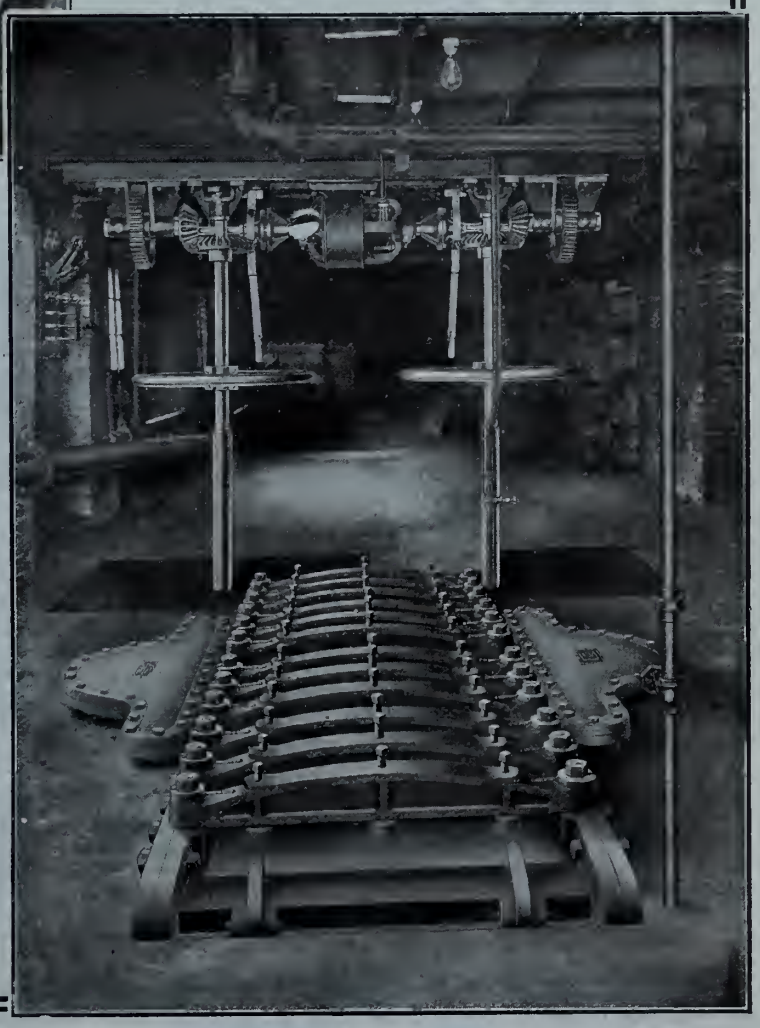
The photograph opposite shows one way of keeping such debris as sticks, leaves, etc., from being drawn into your pumps, condensers and other apparatus.

A diver is engaged periodically to go down under the water to remove the debris that accumulates around the strainer on the inlet of the intake pipe.

The photograph below shows another way of keeping debris from entering your plant via the water intake plan.

A Twin Strainer is used to catch all solids, such as fish, sticks, leaves, twigs, stones, etc., that are carried along in the water. These solids are retained in the baskets of the Strainer, where they can be readily removed at any time without interrupting the flow of water, for when the water is flowing through one set of baskets the other set is out of service.

Motor operated Twin Strainer in 42-inch suction line to condenser—Toledo Railways & Light Company. The motor and operating apparatus is overhead, where it will not be damaged during high water seasons.



Some of the many advantages of the Twin Strainer installation will be readily apparent.

The most obvious one is the convenience of cleaning, which is an assurance against interruptions to the service. The Twin Strainer can be cleaned once or forty times a day, as conditions demand. It can be located in any convenient place inside the plant, where it is accessible at all times.

Twin Strainers will strain water, oil, or any other liquid, and are furnished for either motor or manual operation, in all sizes from 1 to 48 inches inclusive. The basket equipment is varied to suit conditions. Complete information in Bulletin "A." A copy is yours on request.

Elliott Company

6902 Susquehanna St., Pittsburgh, Pa.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lap-welded
1 in.	$36 00	$.....
1¼ in.	40 00	.....
1½ in.	43 00	36 00
1¾ in.	43 00	36 00
2 in.	50 00	36 00
2¼ in.	53 00	38 00
2½ in.	55 00	42 00
3 in.	64 00	50 00
3¼ in.	.....	58 00
3½ in.	77 00	60 00
4 in.	90 00	75 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$13 00	$13 00
Heads	13 30	13 30
Tank plates, 3-16 in.	13 65	13 25

WROUGHT PIPE

Effective July 5, 1917

Black Galvanized

Standard Buttweld

Size	Per 100 feet
⅛ in.	$ 5 00
¼ and ⅜ in.	5 12
½ in.	6 46
¾ in.	8 17
1 in.	12 07
1¼ in.	16 33
1½ in.	19 53
2 in.	26 27
2½ in.	42 12
3 in.	55 08
3½ in.	69 92
4 in.	82 84

Standard Lapweld

2 in.	29 23
2½ in.	43 88
3 in.	57 38
3½ in.	71 76
4 in.	85 02
4½ in.	96 52
5 in.	112 50
6 in.	145 90
7 in.	190 40
8L in.	200 00
8 in.	230 40
9 in.	276 00
10L in.	256 00
10 in.	329 60

	Per 100 feet
⅛ in.	$ 6 50
¼ and ⅜ in.	7 16
½ in.	8 03
¾ in.	10 29
1 in.	15 22
1¼ in.	20 59
1½ in.	24 61
2 in.	33 12
2½ in.	52 94
3 in.	69 23
3½ in.	86 94
4 in.	103 00

2 in.	35 71
2½ in.	54 11
3 in.	70 76
3½ in.	89 70
4 in.	106 28
4½ in.	121 29
5 in.	141 34
6 in.	183 36
7 in.	238 00
8L in.	250 00
8 in.	288 00
9 in.	345 00
10L in.	320 00
10 in.	412 00

Prices—Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES

4" and under, 45%.

4½" and larger, 40%.

4" and under, running thread, 25%.

Standard couplings, 4" and under, 35%.

4½" and larger, 15%.

IRON PIPE FITTINGS.

Canadian malleable, A, add 7½%; B and C, 10%; cast iron, 35%; standard bushings, 50%; headers, 60; flanged unions, 40; malleable bushings, 50; nipples, 55%; malleable lipped unions, 50%.

COLD ROLLED SHAFTING.

At mill	list plus 40%
At warehouse	list plus 50%

Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$5 25
Steel bars, base, Toronto	5 50
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	5 25
Steel bars, base, Montreal	5 50
Reinforcing bars, base	5 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28	$11 00	$11 00
Sheets, Black, No. 10	12 00	12 00
Canada plates, dull, 52 sheets	12 00	12 00
Canada plates, all bright	12 50	12 50
Apollo brand, 10¾ oz. galvanized	12 25	12 09
Queen's Head, 28 B.W.G.	11 75	10 75
Fleur-de-Lis, 28 B.W.G.	11 75	10 75
Gorbal's Best, No. 28	12 00	10 25
Colborne Crown, No. 28	11 25	10 00
Premier, No. 28 U.S.	13 75	12 70
Premier, 10¾ oz.	13 85	13 00

PROOF COIL CHAIN

B

¼ in.	$12 00
5-16 in.	11 50
⅜ in.	11 15
7-16 in.	10 90
½ in.	10 70
9-16 in.	10 70
⅝ in.	10 50
¾ in.	10 40
⅞ in.	10 25
1 in.	10 10
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	40
Delta Files	37½
Nicholson	40
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb	40
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal	26½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 50
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	11

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	$13 05
Connelsville Foundry Coke	.....
Steam Lump Coal	.....
Best Slack	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers	list plus 20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass	add 20
Machine screws, o. and fil. hd., brass	add 25
Nuts, square blank	add $1 50
Nuts, square, tapped	add 1 75
Nuts, hex. blank	add 1 75
Nuts, hex. tapped	add 2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	17½
Boiler rivets, base ¾" and larger	$8 50
Structural rivets, as above	8 40
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly	$0 36
Solder, guaranteed	38½
Babbitt metals	18 to 70
Soldering coppers, lb.	0 53
Putty, 100-lb. drums	4 35
White lead, pure, cwt.	18 00
Red dry lead, 100-lb kegs, per cwt.	15 45
Glue, English	0 38
Gasoline, per gal., bulk	0 31½
Benzine, per gal., bulk	0 30½
Pure turpentine, single bbls., gal.	0 78
Linseed oil, raw, single bbls.	1 42
Linseed oil, boiled, single bbls.	1 45
Lead wool, per lb.	0 15
Plaster of Paris, per bbl.	2 50
Plumbers' oakum, per cwt.	9 00
Sandpaper, B. & A.	list plus 20
Emery Cloth	list plus 33 1-3
Borax, crystal	15
Sal Soda	0 03½
Sulphur, rolls	0 05
Sulphur, commercial	0 04½
Rosin "D," per lb.	0 03
Rosin "G," per lb.	0 03½
Borax crystal and granular.	0 15
Wood alcohol, per gallon	2 15
Whiting, plain, per 100 lbs.	2 20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$55 00	$53 00
Plain sheets, 14 oz., 14x28 in., 14x60 in.	55 00	53 50
Copper sheet, tinned, 14x60, 14 oz.	60 00	54 25
Copper sheet, planished, 14x60 base	64 00	60 00
Braziers', in sheets, 6x4 base	55 00	52 00
Tubing, seamless	58 00	58 00

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 55
Brass sheets 8" wide, 20 oz.	0 60
Brass tubing, seamless	0 57
Tubing, I.P.S., 1" base	0 54

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto	Net

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White	Cents per lb
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets	list plus 10
Planer head bolts, with fillet	list plus 10 and 10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws	list plus 20
Collar screws	list plus 30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts	add 40, 10
Cold pressed nuts to 1½ in.	add $4 50
Cold pressed nuts over 1½ in.	add $7 00

METALS

	Montreal	Toronto
Lake copper	$31 00	$32 00
Electro copper	31 00	32 00
Castings, copper	30 00	31 00
Tin	63 00	63 00
Spelter	10 50	10 50
Lead	11 00	10 75
Antimony	18 00	19 00
Aluminum	65 00	62 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided	0 34
Packing, No. 1 Italian	0 40
Packing, No. 2 Italian	0 32
Pure Manila rope	0 39
Transmission rope, Manila	0 45
Drilling cables, Manila	0 41

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft.	$18 00	$18 00
Sheets, 3½ lbs. sq. ft.	18 00	18 00
Sheets, 4 to 6 lbs., sq. ft.	17 50	17 50

Cut sheets, ½c per lb. extra.

Cuts sheets to size, 1c per lb. extra.

TEN YEARS AGO AND TODAY

Old style Rotor permanently abandoned seven years ago.

Ten years ago—before we brought our Turbine to its present high degree of perfection—the manufacturing difficulties made it impossible to produce a solid rotor without semi-circular slots. These slots are acknowledged as highly undesirable and built-up rotors are never made with them. We finally invented and patented a process of manufacture whereby we were able to eliminate the slots and today unslotted buckets in solid rotor are AN EXCLUSIVE STURTEVANT FEATURE.

The unslotted bucket is obviously much stronger and permits of a thinner and more efficient vane. Furthermore it is self-evident that the slots encourage leakage from one bucket to the next and this further reduces the efficiency.

The unslotted bucket is just one of the superiorities of the Sturtevant steam turbine. The other advantages are given in detail in our catalogs 209 and 210, copies of which will be sent on request.

Improved Sturtevant Rotor—Cannot be duplicated due to patents.

B. F. Sturtevant Company

of Canada, Limited, Galt, Ontario

MONTREAL TORONTO WINNIPEG VANCOUVER

Selling Agents for Sanford Riley Stoker Co., Limited, THE RILEY STOKER

Sturtevant

This trap can be installed in any position desired as it has two outlets.

This is a remark very often made by users in reference to—

The LONG Patent Steam Trap

Has But One Movable Part

Valve is actuated by the expanding and contracting of a tube, a motion that is positive and of sufficient force to close the valve against a pressure of two hundred pounds.

The Long Trap is automatic and requires no valves except those which control admission of steam to apparatus to which trap is attached. It is capable of draining from 900 to 1,500 feet of one-inch pipe.

There are other superior points about the Long Steam Trap. as it could be used as a condenser for heating water for washing bottles, etc., and still remain a trap. Let us tell you the complete story of this wonderfully successful power house facility.

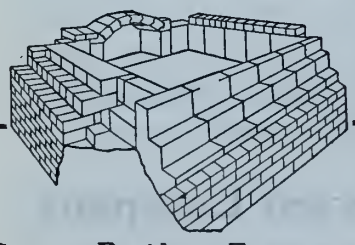
Write.

J. T. LONG

84 Adam Street

MONTREAL, CANADA

If your dealer does not sell it, write direct.



Gates Boiler Furnace

Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

WRITE FOR PARTICULARS

John W. Gates 2 St. James St., MONTREAL, QUE.

TRADE GOSSIP

The Winnipeg Tool & Forging Co., Winnipeg, Man., is being reorganized. The company manufacture a line of mechanical tools, mason's tools and wrecking bars, etc.

New Rapid Tanning Process.—An Australian says he has discovered a new rapid tanning process with which sole leather can be tanned in seven days, calfskins in six hours, and other skins proportionately quickly.

U. S. Steel Orders Decrease.—Unfilled orders of the United States Steel Corporation on October 31 last were 9,009,675 tons, according to the monthly report issued. This is a decrease of 823,802 tons from the orders of September 29, and is the sixth successive monthly decrease.

All U.S. Lake Boats for the Atlantic.—A report from Sault Ste. Marie, Mich., states that it was recently announced by a prominent official of the United States Engineering Department that all Government boats now in northern waters are to be withdrawn immediately and placed in the Atlantic service.

Mineral Production in N.B.—During the calendar year 1916, New Brunswick produced $878,446 worth of minerals. The coal values aggregated $367,041, against $309,612 in 1915 and $241,075 in 1914. New Brunswick produced in 1916, 610,118 thousand cubic feet of natural gas, valued at $79,628. The production of petroleum in the province last year was 1,345 barrels, as against 1,020 in 1915.

U. S. Build 8,000-Ton Vessels.—The American International Corporation has received an order from the Emergency Fleet Corporation for seventy 8,000-ton vessels, to be built within one year of the completion of its plant at Hog Island. This is in addition to the previous order for fifty 7,500-ton vessels. The new contract involves about $100,000,000. The Hog Island plant is scheduled to be finished on December 1.

The Canadian Link-Belt Co. announces its ability to again furnish "Link-Belt" mono-rail electric hoists for quick shipment. These machines are made at the Philadelphia plant, where a large additional building is rapidly nearing completion and the already excellent manufacturing facilities are being greatly increased. Both types C-1 and C-2 can be furnished, the safe lifting capacities ranging from 1,000 lbs. to 6,000 lbs. They can be adapted for either direct or alternating current and fitted with plain hand-geared cord operated motor, or a cage operated motor trolley.

Montreal, Que.—The first deliveries on the Canadian Government railway car order recently placed with the Canadian Car and Foundry Co. will be made within the next two weeks. Some delay was caused through the inability of the car company to obtain steel for this business, but both the Nova Scotia Steel Co. and Steel Company of Canada are now making regular deliveries, and within the next month the company will be turning out fifty cars per day. The Fort William, Montreal and Amherst plants are all engaged on this order, the output of the Amherst plant having increased from two to ten stock cars per day during the past few weeks.

Oil-Burners Must Use Coal.—Increased demand for fuel oil in the war on the Atlantic, which makes the liquid much less plentiful than on the Pacific Coast, has resulted in a decision to remove oil burners from the Cunarder War Viceroy and convert the furnaces into coal burners. The ship is now in the north, and as soon as it returns to its home port the change will be effected. Conditions are now practically the reverse to what they were a few years ago, when many of the steamship lines were outfitting their coal-burning vessels with facilities for using oil as a power medium. In view of the war conditions, it is thought that all of the steamers building on the Pacific Coast that are intended for service on the Atlantic will be coal burners, while the wooden vessels in the Pacific will use oil.

Oil and Gas Development in N.B.—The oil and natural gas development in Westmoreland County, New Brunswick, is making satisfactory progress. During the past year several of the wells were deepened and increased flow obtained. The natural gas is sold under contract to a Moncton corporation, which acts as distributing agent. The total number of domestic consumers of the gas in Moncton and adjoining territory last year was 2,824. The gas is also used by the Canadian Government Railways for their gas engines and forges at the Moncton shops, and by the Plaster Works of the Albert Manufacturing Co., of Hillsboro. The value of the gas produced last year is estimated at $7,936.37. Arrangements have been about completed for the sale of all the company's crude oil to a manufacturing plant at New Glasgow, N.S.

Tungsten Production in N.B.—A very interesting development of wolframite or tungsten is in progress at Burnt Hill on the South West Miramichi, New Brunswick. This metal is extensively employed in the manufacture of high speed steel and armor plate. As the Imperial Government has commandeered for its own use all of the metal of this kind in the empire, the successful development of this provincial prospect possesses more than local interest. The company has erected a concentrating mill at the water's edge of the Miramichi River, for the treatment of the ore as it is taken from the mine. A shaft 65 feet deep has been opened up to follow the vein in two directions. The mine is equipped with steam hoisting apparatus, and air compressor for the drills. The vein of ore is about four feet in thickness and is nearly vertical.

Building Sternwheelers at Yarrows.—The steel sternwheelers which have been built for delivery in India by the Esquimalt branch of Yarrows, Ltd., have given such satisfaction that another contract for a vessel of similar type has been placed with the concern by another com-

pany. Yarrows, Ltd., is already working on a contract for four sternwheelers, two having been finished and put into service, while the other two are under construction. After being fully assembled at the Esquimalt yards and placed in readiness for the water, the vessels, which are of extremely light draught and practically flat-bottomed, are "knocked down" and the parts shipped to the Orient, where they are re-assembled and put in running order again. They are used almost entirely for river navigation. The latest contract is for a vessel 185 feet long, with a 37-foot beam.

Ottawa, Ont.—Assistant City Engineer Askwith has been given permission to call for tenders on the supply of an apparatus for thawing out city water pipes. The style of apparatus the engineer desires is gasoline-driven and mounted on sleighs. The estimated cost is $3,500.

Armagh, Que.—Gauvin & Beauchemin, civil engineers, Quebec, Que., are preparing plans and specifications for power development at Armagh, County Bellechasse, on River Fourche-du-Nord-Ouest, and will receive tenders for water turbines, dynamos, sluice-gates, penstock and wooden pipes, etc.

Winnipeg, Man.—Tenders will be received by the Commissioners of the Greater Winnipeg Water District up to Monday, Nov. 26, 1917, for the following:—Construction of tunnel, shafts and well at the Red River crossing; supply of cast iron gate valves, air valves and sluice gates, construction of gate house and intake at Waugh, Man. Specifications may be obtained on application at the office of the District, 501 Tribune Bldg., Winnipeg. R. D. Waugh, Chairman of Commissioners.

Winnipeg, Man.—Tenders will be received up to Monday, Dec. 3, 1917, by the Commissioners of the Greater Winnipeg Water District for the following: Construction of a pressure pipe line from Red River to McPhillips Street Reservoir; manufacture and supply of 48-inch pre-moulded reinforced concrete pressure pipe; supply of cast iron pipe and specials. Specifications may be obtained on application at the office of the District. 501 Tribune Bldg.. Winnipeg. R. D. Waugh, Chairman of Commissioners.

Port Arthur, Ont.—Tenders will be received until Monday, November 26. 1917, for the construction of a temporary pile protection breakwater at Port Arthur, District of Thunder Bay and Rainy River, Ont. Plans and forms of contract can be seen and specifications and forms of tender obtained at the Department of Public Works, Ottawa, and at the offices of the District Engineers, Equity Building, Toronto, Ont.; Sault Ste. Marie, Ont., and Port Arthur, Ont.

St. John, N.B.—J. Fred Belyea proposes erecting a sardine canning plant at West St. John, to cost $90.000.

Regina, Sask.—The Saskatchewan Co-operative Elevator Co. will rebuild the elevators at Maryfield and Raymore, which were destroyed by fire.

St. Catharines, Ont.—A portion of the

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damaged by fire on Nov. 6, which was discovered in the stock or finishing-room. A large quantity of finished stock was destroyed by fire and water. The loss is covered by insurance.

Lindsay, Ont.—H. E. Hunt, of Chicago, Ill., has been here for the purpose, it is said, of looking over the town with a view to establishing a Canadian factory Kinleith Paper Co.'s mill was seriously for the manufacture of a special brand of leather for use in automobiles, upholstering, etc. A factory will also be established in the United States.

St. John, N.B.—The grain elevator being built by the Fegles-Bellowes Co. for the Canadian Government Railways, is approaching completion. The concrete substructure is practically complete, and the workmen are now employed on the steel super-structure, which will be 100 feet in height. The capacity of the first unit of this elevator will be 500,000 bushels. The re-building of No. 5 warehouse on the western side of the harbor is being proceeded with by Kane & Ring, contractors.

Lethbridge, Alta.—The City Council contemplate the installation of power plant equipment costing $63,000.

Bienville, Que.—The Town Council will call tenders for turbine pump for waterworks.

Ottawa, Ont.—The tender of the Otis-Fensom Elevator Co., $1,862, was the lowest received on the supply of an elevator for the city workshop on Chamberlain Avenue. The tenders were referred to the engineer.

Toronto, Ont.—The City Council has given the Toronto Board of Harbor Commissioners authority to sell industrial sites, covering 139 acres, on the northerly part of Ashbridge's Bay industrial area, east of Leslie Street. The sale of four acres in this section at $15,000 to the Imperial Oil Co. has been confirmed by the Council.

CATALOGUES

Brass Foundry Equipment.—Catalogue No. 128 illustrates and describes a line of equipment for brass foundries, such as furnaces, tumblers and tongs, etc. The catalogue is fully illustrated and includes tables of sizes.

Insulating Bricks for Boilers.—The Armstrong Cork & Insulation Co., Pittsburgh, Pa., have issued a folder, just off the press, bearing the title "Nonpareil Insulating Brick for Boiler Settings." The folder states what this type of brick is composed of, and also gives particulars of tests. Copies of this folder may be had free of charge on request.

The Whiting Converter is the title of a new catalogue No. 129 issued by the Whiting Foundry Equipment Co., Harvey, Ill. The catalogue deals with the construction and principal features of the Whiting side-blow steel converter, and also describes the process of making steel castings by this method. The catalogue is fully illustrated, showing a number of installations.

Adjustable Speed Motors.—Bulletin No. 41021, issued by the Canadian General Electric Co., Toronto, deals with the R.F. adjustable speed motors. The principal characteristics and other important features embodied in this line of motors are given in detail, accompanied by illustrations showing various types and details of parts. A table of dimensions covering the various sizes is also included.

BOOK REVIEWS

First Aid Instructions for Miners, a booklet, pocket size, issued by the Bureau of Mines, Department of the Interior, Washington, D.C. This handbook contains a report on standardization of advanced first aid instructions for miners, compiled by a committee of surgeons appointed to formulate in detail methods of giving first aid instruction to miners for the various classes of injury that were likely to take place in mines. The handbook contains much valuable information on this important subject, presented in a clear and concise manner. The handbook contains 163 pages, 65 illustrations and a complete index. Copies with paper covers may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., for 20c. An edition in stiff covers has been issued at 35c per copy.

Rural Planning and Development.—The latest report of the Commission of Conservation deals with the important subject of the planning and development of rural districts and small towns in Canada. It has been prepared by Thomas Adams, Town Planning Adviser of the Commission, who has made a close study of the problems of rural development in this country during the past three years, following twenty-five years experience in farming, land surveying and town planning in other countries. The report deals comprehensively with the social conditions and tendencies in rural areas and the prevailing systems of land settlement and development. It indicates the rural problems requiring solution in order to secure the proper development and economic use of land for purpose of efficiency, health, convenience, and amenity. The great injury which land development in Canada suffers, from speculation, neglect of public health, and want of expert business administration of land settlement, is considered. Incidentally, the problem of returned soldiers is dealt with, and the connection between land development and such questions as taxation, unemployment, and high cost of living is clearly shown. Having regard to the need for more attention being given to production in Canada, to the extent to which production is impaired by speculation in land, by neglect of public health, and by haphazard systems of development; to the importance of increasing the supply of human skill and energy and of capital derived from production instead of by borrowing, the problems dealt with in this report are of vital and current interest to the people of this country.

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WHAT IT ACCOMPLISHES It gives the valve a rigidity of form. It keeps the surface of the valve in its normal true position and insures a better seating quality. It prevents the high pressure from forcing the valve through the grating. It prevents the rubber from breaking up and the pieces causing trouble. It holds the surface of the valve in shape, so that when one side becomes worn the valve can be reversed without dressing. It is thinner and therefore gives greater efficiency to the pump. It permits the use of a softer valve for hot water, thus securing a better seat on worn or uneven "grids." It ensures an even distribution of the pressure, preventing "dishing" and the consequent cutting of the valve.

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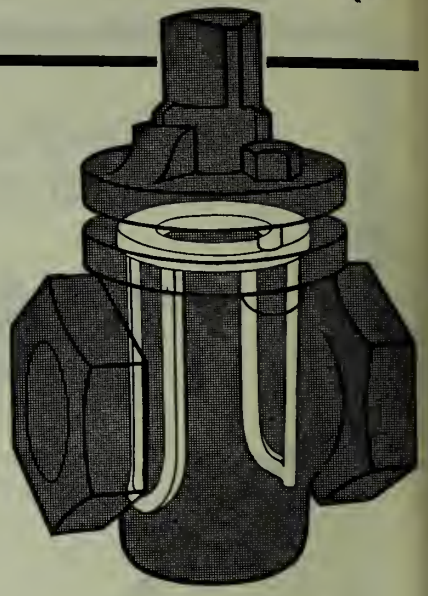

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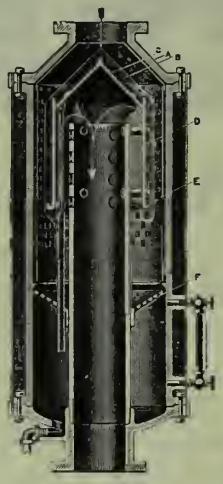

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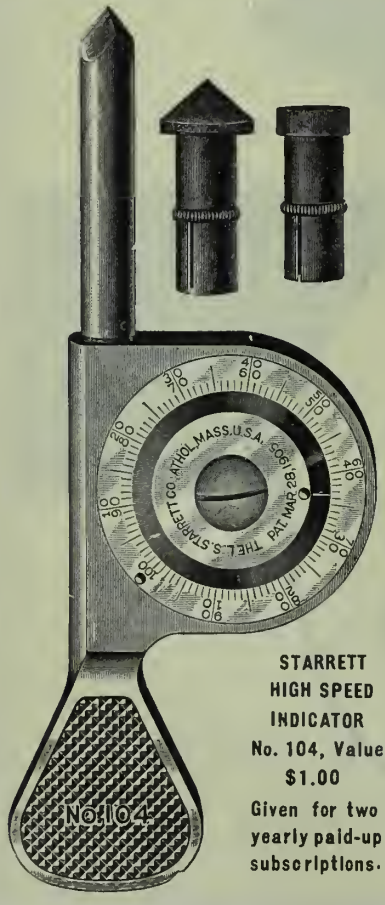

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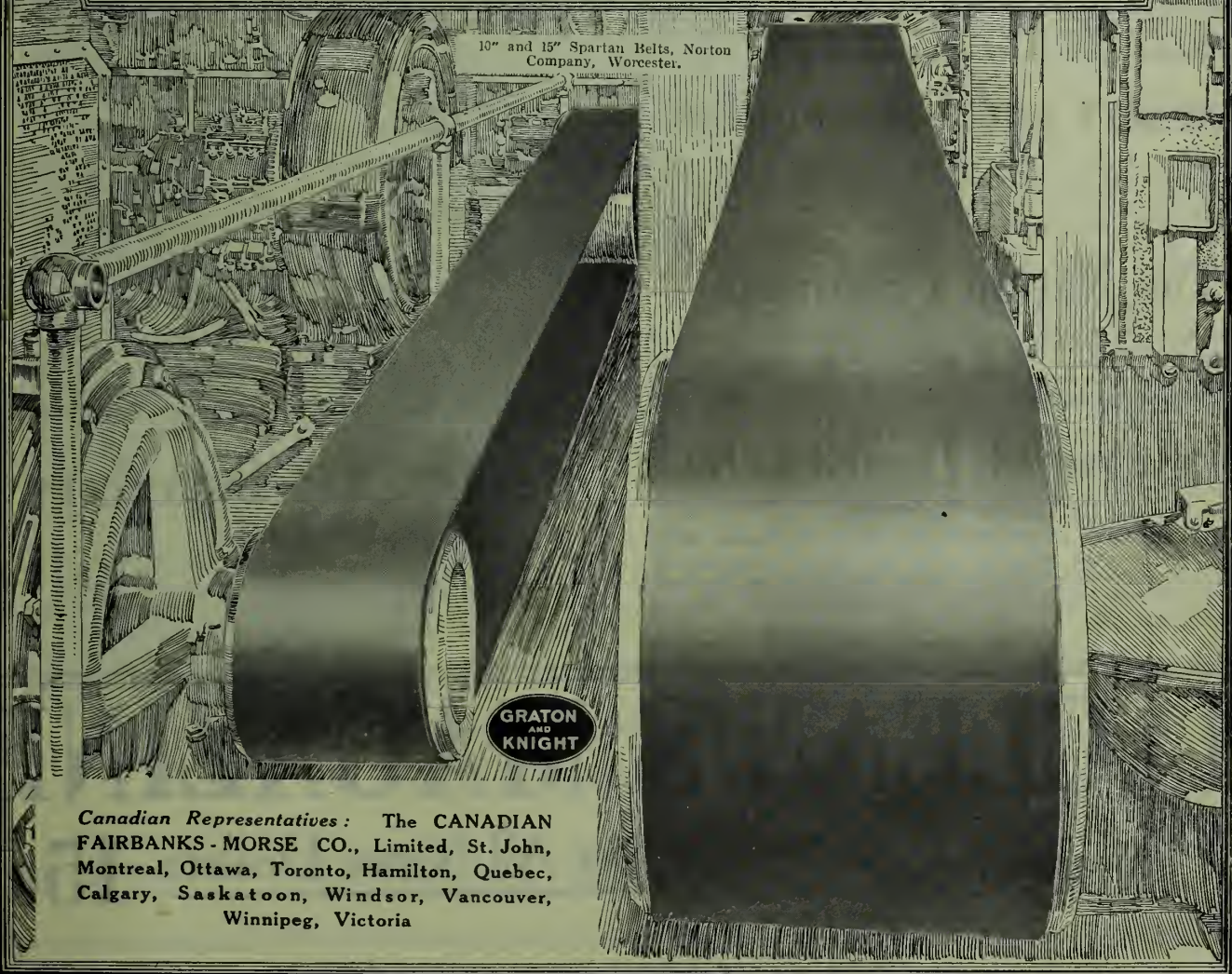

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Escaped from Germany

AN escaped prisoner tells the story of his fearful experiences in Germany in MACLEAN'S MAGAZINE for November; and gives a vivid picture of conditions in Germany as he saw them. He got out by way of Holland after appalling perils and hardships. In Holland, he was photographed, but so altered was he that his wife quite failed to recognize him in this photograph. Read this story of this Canadian soldier's escape. It is gripping stuff—a rare tale.

Canadian Finances After the War

WILL business in Canada collapse when peace comes? It may. What do the big men say? What do they know? What do you think? Are your opinions well informed? The subject is of the greatest possible importance, and you will get light and leading by reading the contribution of Col. John Bayne Maclean, who has taken the trouble to get the opinion of the biggest and most highly placed men in Canada to help him prepare his article.

Back from the Arctic

WILLIAM THOMPSON, representing the American Geographical Society, was this year in the Arctic Regions. He went to the delta of the Mackenzie River, and took many excellent pictures of the country and its Eskimo inhabitants. He makes the November MACLEAN'S the vehicle of many of his pictures and for an account of his journey. Read what this Arctic scientist has to tell us about a remote part of our land.

Slackers and Conscription

WHAT is your attitude towards the draft? You have positive opinions, of course. How do they square with Miss Laut's as they are expressed in her ringing article on Slackers in the November MACLEAN'S?

The Nation's Business

THIS is a new feature—a fearless, well-informed survey of national affairs. What we all want is an outspoken—but not vindictive—and clear-visioned presentation of factors and facts affecting our national, political and economic welfare.

Sketches of Trench Life

By Gunner McRitchie

MCRITCHIE was a cartoonist on a Western Canada daily before he went overseas. He has done a number of sketches of trench life "On the Spot," and these he has sent home, for publication in MACLEAN'S MAGAZINE. They're interesting and good.

The Late Sir Mortimer Clark

BEFORE he died, a few week ago, the late Sir Mortimer Clark, eminent jurist and an ex-Lieutenant-Governor of Ontario, wrote for MACLEAN'S an article on "Safeguarding Your Heirs." It has to do with the functions, service and safety of Trust Companies as executors of estates. This article by a man so distinguished, so cautious, so able, and so wise a counsellor, can be of first-rate value to every man perplexed with the problem of how his estate can be safely and prudently administered after he, the testator, has passed from this life.

A Complete Novelette

By Peter B. Kyne

HIS story in the November MACLEAN'S is a thunderingly good story of lumbermen and lumbering. Red blood is in this tale of business. R. M. Brinkerhoff illustrates it.

Short Story

By Ethel Watts Mumford

THE writer of this short story—the first of a delightful series by this author to appear in MACLEAN'S—is very well known among short story writers. Delicate fancy, wholesomeness, freshness and finished workmanship characterize all her work.

Short Story

By W. A. Fraser

A MIGHTILY well-written story of India—the kind that we all delight in; tense, bewildering, and lots of action. Fraser never wrote a better short story than this. Ben Ward illustrates it.

Hendryx and Oppenheim

SERIALISTS

"THE Gun Brand," by Hendryx, comes to an end in the November issue. Oppenheim's greatest story, "The Pawns Count," is continued. Oppenheim's story is the biggest single feature ever secured by MACLEAN'S.

MACLEAN'S MAGAZINE

for November At All News Dealers **15c.**

BEHIND this Diamond Trade-Mark on every Jenkins Bros.' Valve is the 53 years' reputation for Quality Products and trustworthy service.

Constant improvement to meet the varying conditions of valve practice and usage since 1864, has made possible the maintenance of the Jenkins Bros.' guarantee—

"If you will put a genuine JENKINS BROS.' VALVE on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight, or does not hold steam, oils, acids, water or other fluids longer than any other valve—**you may return it and your money will be refunded."**

Leading Engineers no longer buy valve service on manufacturers say-so. They insist on a definite record of accomplishments—facts. JENKINS BROS.' VALVES invite investigation on a fact basis.

AT ALL DEALERS

Catalogue No. 8 sent free on request.

103 St. Remi St. JENKINS BROS. Limited Montreal

Patented Canada, May 29th, 1917. Patented U.S.A., October 25th, 1916.

THE
National Boiler Seam Protector

ABSOLUTELY PROTECTS

Your Boiler From MUD CRACKS, FIRE CRACKS, BLISTERS, LEAKS, thereby eliminating your Repair Account.

A few satisfied large users of this Protector in U.S.A. and Canada to whom we invite you to write.

Mima Valley Hospital, Dayton, Ohio.
Mersman Bros. Brandt Co., Celina, Ohio.
Nicholas File Company, Anderson, Ohio.
New Idea Spreader Company, Coldwater, Ohio.
Olt Brewing Company, Dayton, Ohio.
Planters Manufacturing Co., Clarksdale, Miss.
Palmetto Phosphate Co., Tiger Bay, Florida.
Progress Laundry Co., Indianapolis, Ind.
STANDARD OIL CO., Shelby Hook, N.J.
Shelby Oil Mill Company, Shelby, Miss.
Sloss Scheffield Steel & Iron Co., Birmingham, Alabama.
Srere Pulp & Paper Co., Franklin, Ohio.
Troy Pearl Laundry Co., Dayton, Ohio.
United Paper Board Company, Rockport, Ohio.
Weidman Silk Dyeing Co., Paterson, N.J.
Wagner Manufacturing Co., Sidney, Ohio.
Wood Worsted Mills, Boston, Ohio.
Imperial Drop Forge Co., Indianapolis, Ind.
Illinois Glass Company, Alton, Ill.
Innis Pearce Company, Rushville, Ind.
Knab Brothers Company, Norwood, Ohio.
Lower Vein Coal Co., Terre Haute, Ind.
Lufkin Land & Lumber Co., Lufkin, Tex.
Mead Pulp & Paper Co., Dayton, Ohio.
Manville Company, Providence, R.I.
Meadow Lands & Coal Co., Arella, Pa.
Hamilton Ice & Cold Storage Co., Hamilton, Ohio.
American Writing Paper Co., Franklin, Ohio.
Hamilton Foundry & Machine Company, Hamilton, Ohio.
Hartford City Paper Co., Hartford City, Ind.
Hamilton Otto Coke Co., Hamilton, Ohio.
Inland Coal & Mining Co., Indianapolis, Ind.
Indiana Ice & Dairy Company, Anderson, Ind.
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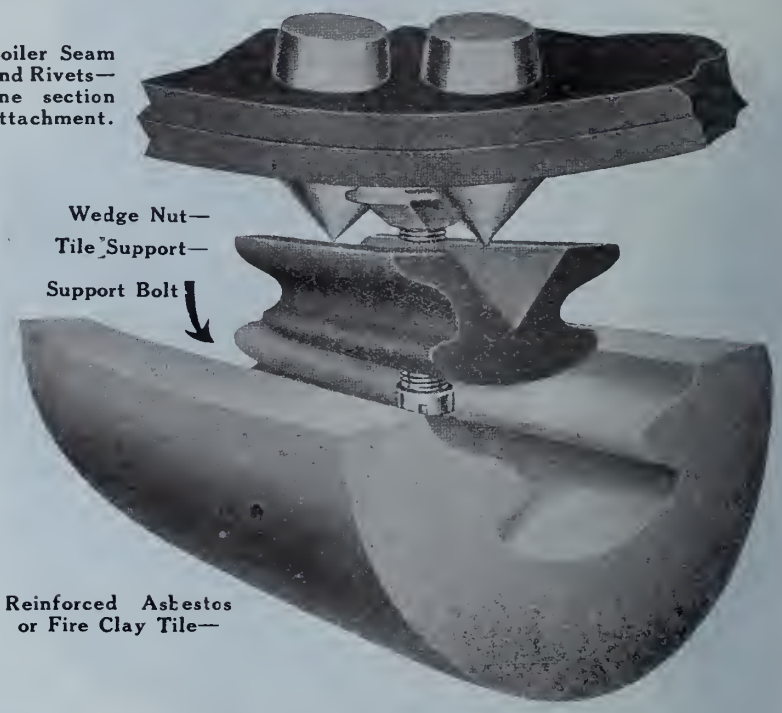
American File Renewing Co., Anderson, Ind.
Boss Washing Machine Co., Norwood, Ohio.
Borden's Condensed Milk Co., New York City, N.Y.
Born & Company, La Fayette, Indiana.
Canton Stamping & Enameling Co., Canton, Ohio
CARNEGIE STEEL CO., Pittsburgh, Pa.
Crystal Paper Company, Middletown, Ohio.
Chickasaw Milling Company, Chickasaw, Ohio.
Dayton Lumber Company, Dayton, Ohio.
Ducktown Sulphur, Copper & Iron Co., Isabella, Tenn.
Estate Stove Company, Hamilton, Ohio.
Economy Soap Products Co., Dayton, Ohio.
Frost-Johnson Lumber Co., Campti, La.

THIS IS IT



The illustration above shows one complete section of this National Protector. Five such sections make the National Boiler Girth Seam Protector.

Howard Smith Paper Mills, Beauharnois, Que. Dominion Copper Products Co., Montreal; Montreal Cotton Mills, Valleyfield, Que.; National Bridge Co., Ltd., Longue Point, Que.; Montreal Locomotive Works, Montreal, Que., and hundreds of other firms who realize the advantage and benefit derived by having this Protector.

EXPRESSIONS OF LEADING BOILER INSPECTORS AND ENGINEERS.

Prominent Government Inspector—It should be on every R. T. Boiler, new or old, as it fills a long-felt want.

Consulting Engineer—There is no doubt as to its merits, and will recommend it to be adopted on all boilers under my supervision.

Factory Superintendent—Our cost in boiler repairs has been enormous, not counting necessity of shutting down. This Protector we have been wanting for some time and will have it put on every boiler where it can be attached.

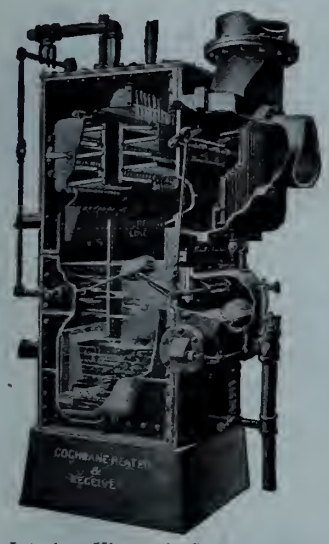
Now it is up to you. Is not Protection and Prevention better than Risk.

SEND FOR CATALOGUE AND PRICE LIST TO

National Boiler Protector Co., of Canada

Head Office: 910 New Birks Building, MONTREAL. Factory: 322 Craig St. W.

STEAM SPECIALTIES
FOR
The Power House



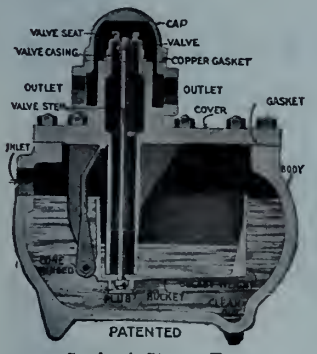
Interior View of Cochrane Open Feed Water Heater

Cochrane Heaters as used in Heating, Metering, and Softening water for boiler feed and other purposes.

Cochrane Separators for removing water from live steam, water and oil from exhaust steam and compressed air.

Cochrane Steam Separator

Cochrane Multiport Safety Exhaust Outlet Valves designed to release steam and prevent accumulation of pressure. They are the only valves of the kind absolutely free from sticking, pounding or overloading.



Squires' Steam Trap

The merits of the Squires Steam Traps have repeatedly been demonstrated in marine service, high pressure power plants, low pressure heating systems, on laundry machinery, steam separators, vulcanizers in rubber plants, dry kilns, drying rolls of paper machines and other places where steam traps are required.

Cochrane Multiport Valves

CANADIAN ALLIS-CHALMERS
LIMITED

Head Office - TORONTO

Sales Offices: Montreal, Halifax, Sydney, Ottawa, Cobalt, South Porcupine, London, Winnipeg, Calgary, Edmonton, Nelson and Vancouver.

Canadian Association of Stationary Engineers

Incorporated May, 1887 — Incorporated at Ottawa, June, 1917

An organization having as its aims and objects:—

To promote the knowledge of its members in the art and science of Steam Engineering.

The dissemination of information beneficial to the members of the association in the discharge of their calling.

To further and protect the interests of competent engineers, and receive such as members of this organization.

To secure, through proper legislation, the greatest security in operation of steam plants.

To assist unemployed members to secure positions.

To maintain freedom of action between employer and employee.

The members of the Association subscribe to the above in the full belief that ability and knowledge of one's profession are necessary to insure the highest degree of success.

Labor Study Energy

These three essentials have been responsible for the success of the world's greatest men. They are no less essential for yours. We cannot all become great, but this fact does not lessen the necessity for the exercise of these essentials in our individual occupations. Cool, calm, calculating judgment characterizes the successful power house operator of to-day. The demands on the engineer of to-day are many, and the obstacles in his path are great. To assist in the overcoming of these and help the accomplishment of great works, material, moral and educational, is the desire of all our members.

The benefits accruing from association with members of his fraternity, the opportunity to benefit by their experience, and the inspiration to greater effort by reason of their success render membership in this association indispensable to all progressive engineers.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

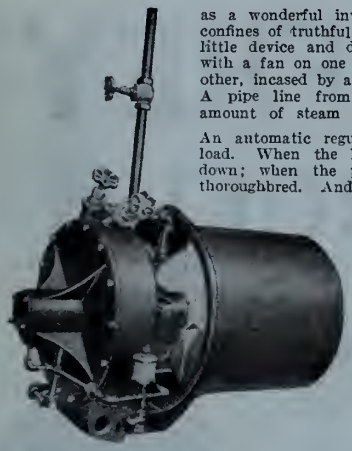
J. H. HALE, General Secretary, C.A.S.E.

230 Caroline Street — Hamilton, Ont.

"Doing Our Bit"

We believe we are "doing our bit" in demonstrating to manufacturers how they can effectively cut down the cost of steam production, better their combustion and increase the capacities of their boilers. In offering the

Coe Turbine Blower



as a wonderful invention, we are well within the confines of truthful advertising. It is such a simple little device and does such a big work! A shaft with a fan on one end and a steam turbine on the other, incased by a shell is about all there is to it. A pipe line from the leader supplies the small amount of steam required.

An automatic regulator adjusts the speed to the load. When the load is light, the blower slows down; when the peak comes it responds like a thoroughbred. And how it does drive the air into the fire! Clinker doesn't get a chance to form.

The gases of combustion which ordinarily pass up the chimney are held back by the draft controller, thoroughly mixed with the air and burned. Nothing gets away that is worth keeping.

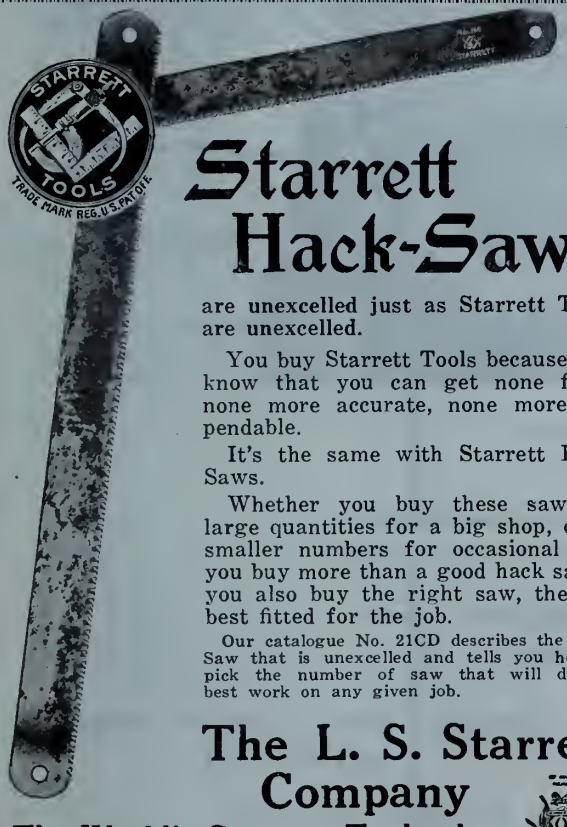
Space limits prevent a complete description of the Coe Turbine Blower. Write for it and receive our special demonstration proposition. You should have it. We solicit your inquiry.

C. T. COE COMPANY

Engineers and Combustion Experts

2-14 JOHNSON ST. NEWARK, N.J., U.S.A.

CANADIAN AGENTS:
The Harland Engineering Co., Montreal, Que.



Starrett Hack-Saws

are unexcelled just as Starrett Tools are unexcelled.

You buy Starrett Tools because you know that you can get none finer, none more accurate, none more dependable.

It's the same with Starrett Hack Saws.

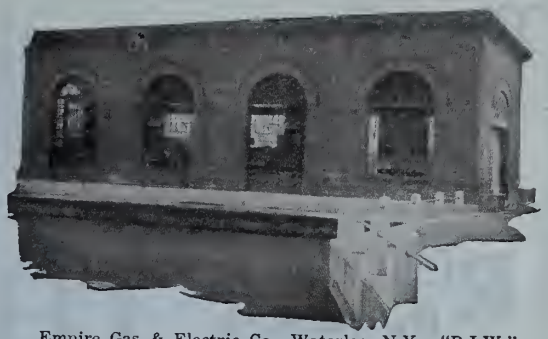
Whether you buy these saws in large quantities for a big shop, or in smaller numbers for occasional use, you buy more than a good hack saw—you also buy the right saw, the one best fitted for the job.

Our catalogue No. 21CD describes the Hack Saw that is unexcelled and tells you how to pick the number of saw that will do the best work on any given job.

The L. S. Starrett Company

The World's Greatest Toolmakers

ATHOL, MASS.



Empire Gas & Electric Co., Waterloo, N.Y. "R.I.W." Cement Filler and Cement Floor Paint used on concrete floors to decorate and preserve them.

Floor Troubles Meet Their Waterloo At Waterloo, New York

The concrete floors of the Empire Gas & Electric Company have been made permanently non-dusting, non-crumbling and non-expensive!

R.I.W. REMEMBER IT'S WATERPROOF — REG. U.S. PAT. OFF.
CEMENT FILLER & CEMENT FLOOR PAINT — PATENTED AS TO PORTLAND CEMENT FEB. 27 1906

This is a combination cement floor treatment that doesn't fear water, oil, acids, alkalies, floor trucks, the vibrations of heavy machinery, or the scuffings of a thousand rough-shod feet.

It hardens the floor by filling its pores and rendering it impermeable to water, oils, acids, alkalies, etc.

It decorates the floor by laying a hard, pleasingly glossy coat in any of twelve standard shades, or special shades to suit.

It stops dusting—and the consequent damage to moving machinery by fine particles of floating concrete dust.

Write for our Booklet about it—No. 59.

Manufactured in Canada by

R.I.W. DAMP-RESISTING PAINT CO.

TOCH BROTHERS

Technical and Scientific Paint Makers since 1848

Gerrard St. and Carlaw Ave., Toronto, Ont.

Agents in Vancouver, Winnipeg, Edmonton, Calgary, Montreal, Quebec, St. Johns.

R.I.W.
REMEMBER IT'S WATERPROOF
REG. U.S. PAT. OFF.
STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

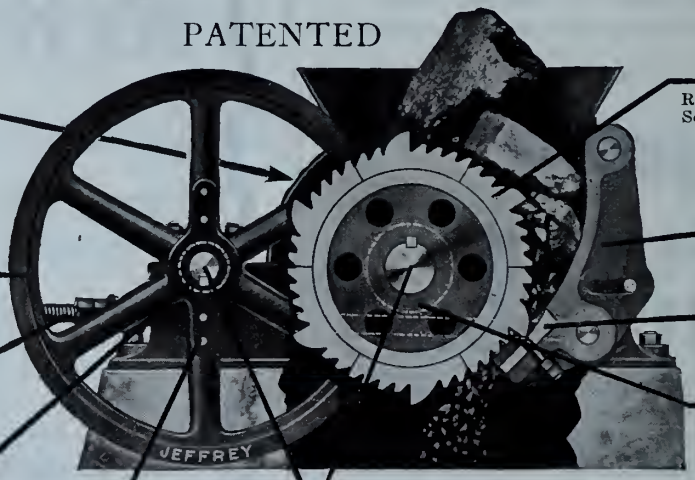
The Recognized Standard Wherever Coal Crushers Are Used

REDUCES Run-Of-Mine or Lump Coal to Stoker Size in one operation

THE JEFFREY SINGLE ROLL COAL CRUSHER

These Points Mean Greatest Freedom From Shutdowns and Renewal of Parts

PATENTED



Cut Tooth Steel Gears with Safety Guard.

Heavy Fly Wheel Pulley.

Tension Rods holding breaker plate and cushioning springs.

Counter Shaft Bearings have renewable Babbitt Bushings

Renewable Manganoid Segments on Crusher Roll.

Adjustable Breaker Plate.

Renewable Manganoid Wearing Shoe.

Roll Shaft Bearings have renewable Bronze Bushings

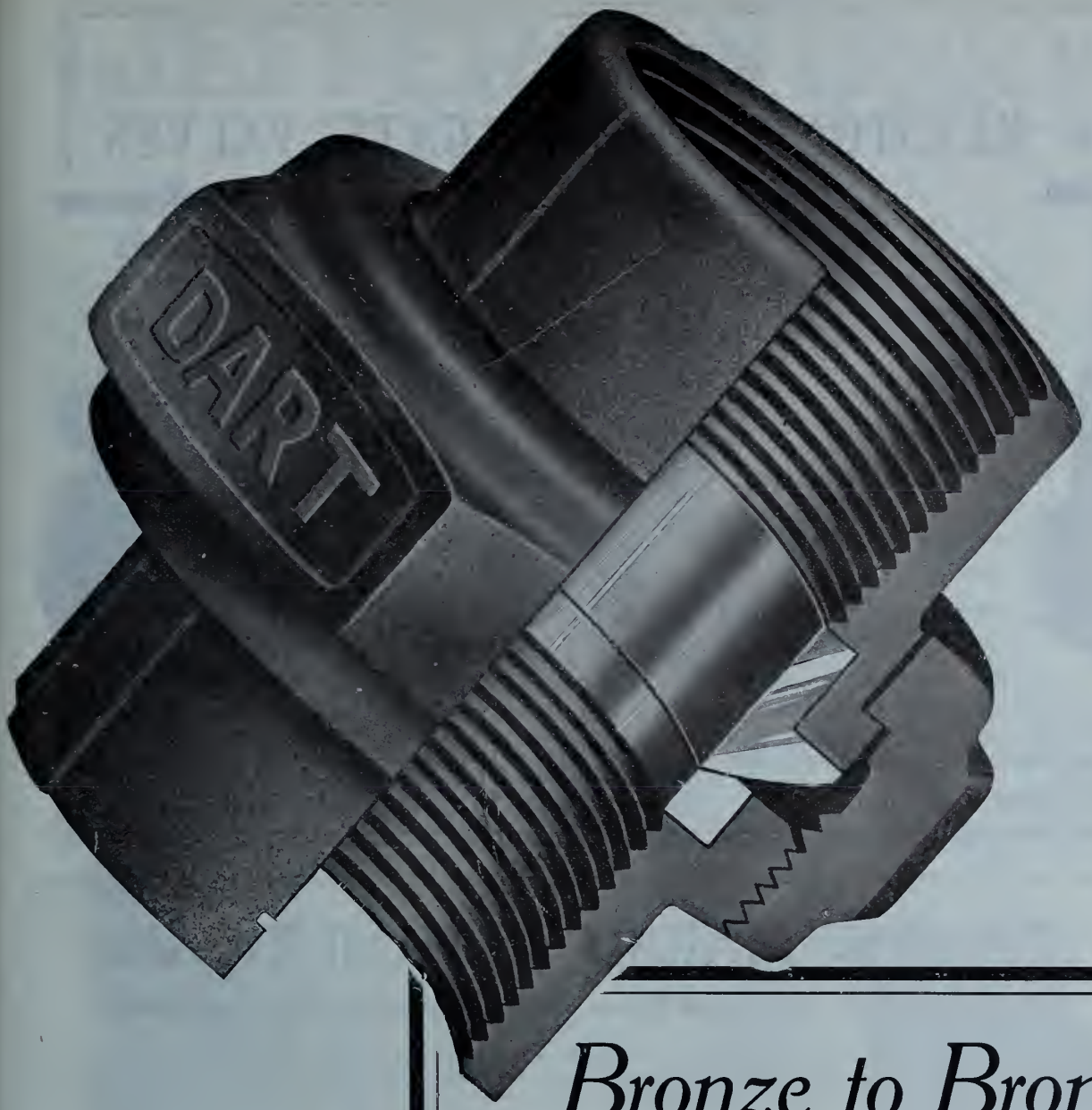
Large Diameter Shafts.

Breaking Pin Safety Device protects against tramp iron.

Bulletin No. 141-C Gives Complete Details
Send For Your Copy

THE JEFFREY MFG. CO. Canadian Branch and Warerooms MONTREAL

Headquarters for Chains and Attachments, Sprockets, Elevators, Buckets, Boots, Casings, Spiral and Belt Conveyer, Gears, etc.



Bronze to Bronze

at the Joint

Therefore no eating away by rust.

A pipe out of line connects with the ease of a pipe in line. The ball-shaped seat is why.

Dart Unions outlive the pipe and without attention from the day connected stay permanently tight.

No cored part to clog with sediment and check the flow

For 24 years sold by all leading supply houses.

Made in Canada by

DART UNION COMPANY, LIMITED
TORONTO, CANADA

BUY VICTORY BONDS—SAFEST INVESTMENT IN CANADA TO-DAY.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN
Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction*. Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under auy unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

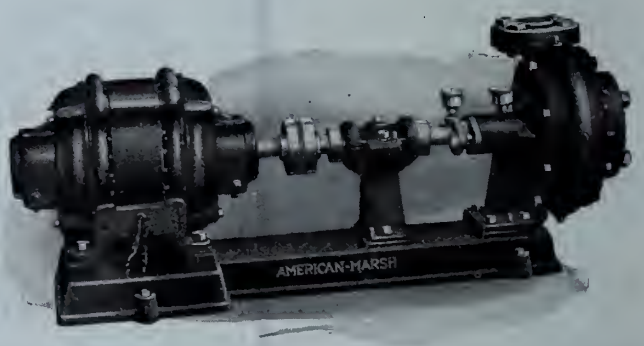
This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs.* Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring olled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

CANADIAN AGENTS

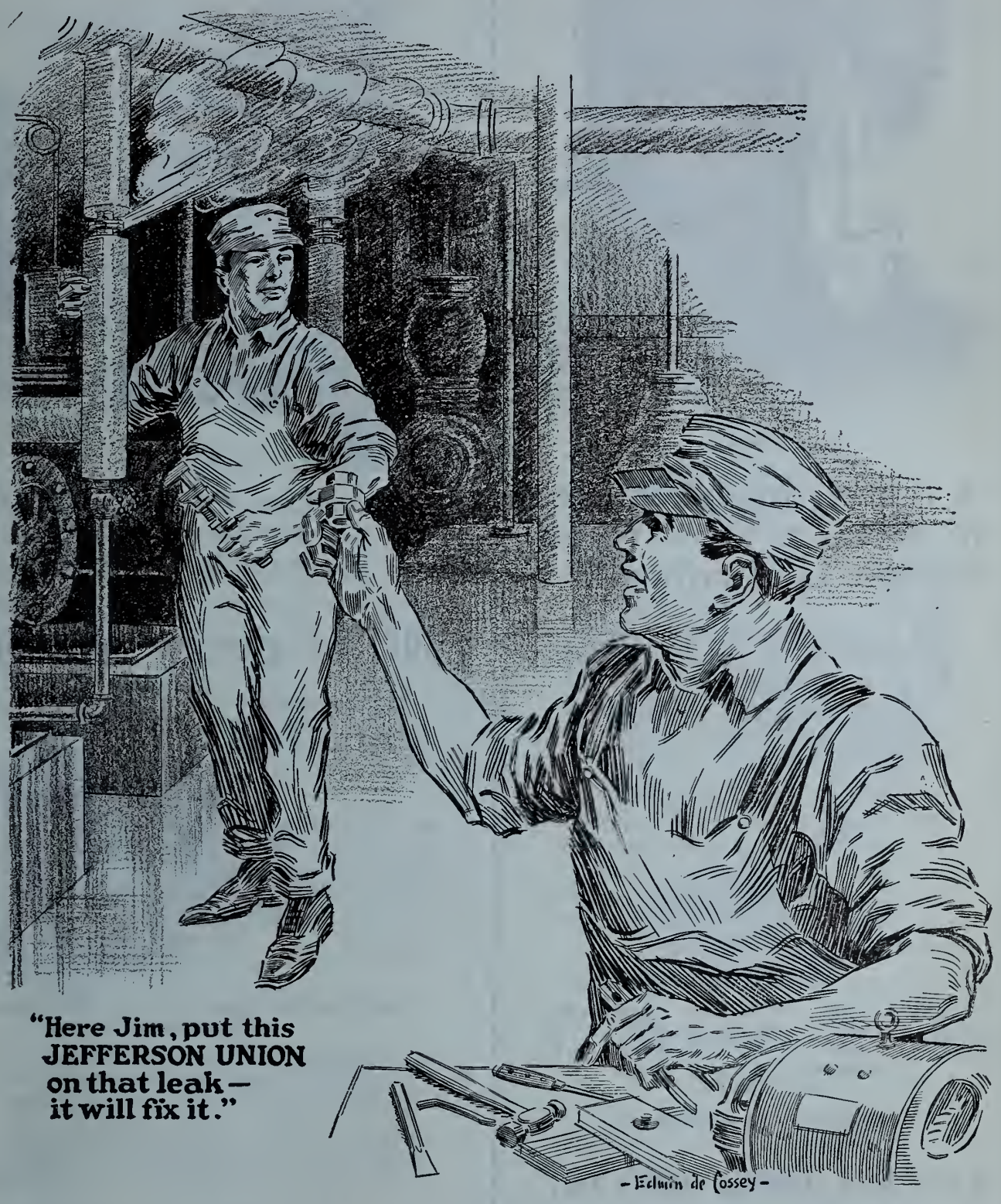
A. R. Willlams Machinery Co., Toronto.
Willlams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company
Battle Creek, Mich.



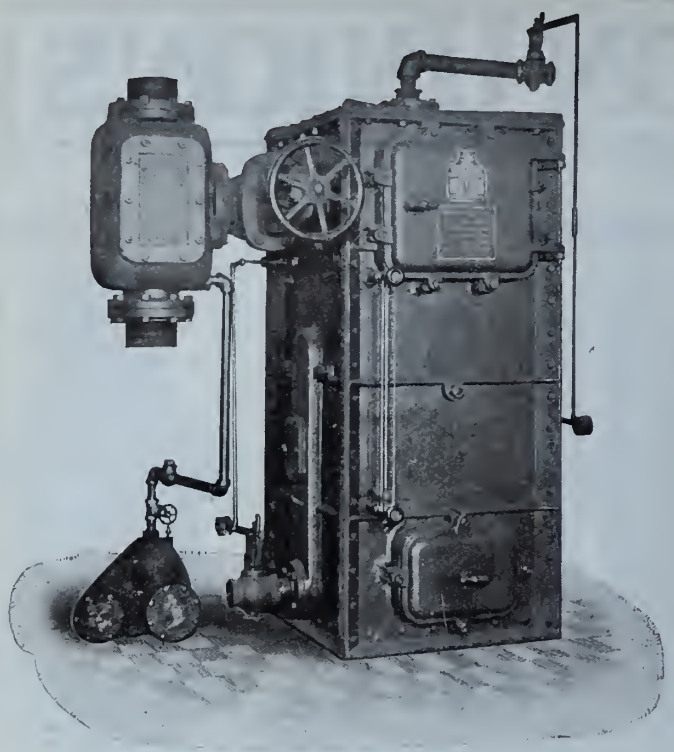
American-Marsh Centrifugal Pump.

JEFFERSON UNIONS



Lexington, Massachusetts

BUY VICTORY BONDS—SAFEST INVESTMENT IN CANADA TO-DAY.



A few of the advantages of Webster Feed Water Heaters and Purifiers—

The temperature of feed-water is guaranteed to be within from 2 to 4 degrees of the temperature of the steam without back pressure on any of the engines with which the heater is connected.

Constructed of cast iron and brass throughout, which materials best resist the acids and gases found in feed waters, they last indefinitely. The greatest efficiency, up to the capacity will be obtained for an indefinite period.

Simplicity of construction, durability and automatic operation are prominent features.

"Webster" Service is the class you like.

Write for full particulars.

DARLING BROS., Limited

120 Prince Street, MONTREAL

TORONTO WINNIPEG

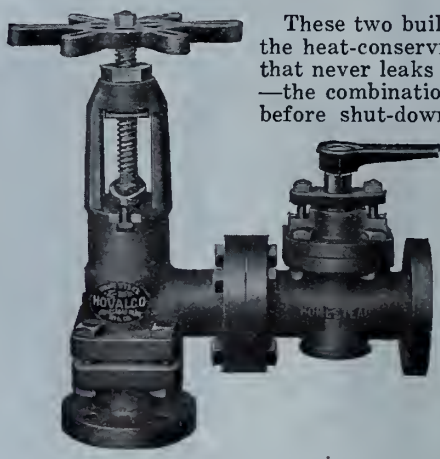
They Can't Clog

and they CAN'T LEAK these

"HOVALCO" RENEWABLE BLOW-OFF VALVE

and

"HOMESTEAD" QUARTER-TURN VALVE



These two built into one make the heat-conserving combination that never leaks and never clogs —the combination that puts NO before shut-downs and blow-off troubles. Why tolerate leaking and clogging valves when less than their trouble cost gives you a combination valve that is always tight?

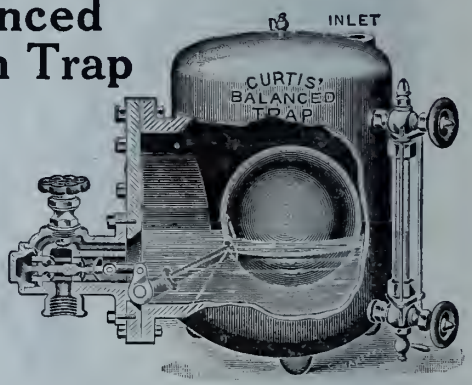
Write for Facts

HOMESTEAD VALVE MFG. CO.

PITTSBURGH, PENNA.

GURTIS Engineering Specialties

Balanced Steam Trap



This trap is often used as a waterline trap on large plants where there is need to balance any particular circulation to prevent snapping and cracking in pipes and radiators.

This Trap Has These Points of Difference and Superiority

1—A perfectly balanced valve.
2—An absolutely frictionless valve.
3—The valve can be removed without breaking a joint, starting a gasket, or taking out a bolt.
4—The valve being frictionless and balanced, the whole power of the float is available for opening and closing the valve.
5—Each trap will operate perfectly on pressure varying from one to 250 lbs.

The great merit of this trap, its simplicity, its dependability and serviceability make it well worth being better acquainted with. Send for special printed matter describing it and giving prices. Address the Manufacturers.

JULIAN D'ESTE COMPANY

Main Office, 26 Canal St., Boston, Mass.

Agencies: 216 Faulton St., New York City; 174 N. Market St., Chicago, Ill.

Globe and Angle Patterns

Playing the game *safe!*

Where boilers are connected in battery the danger incident to the blowing out of a tube, rupture of the shell, etc., increases in direct proportion to the number of boilers unless *each boiler is provided with a Lunkenheimer Non-return Safety Boiler Stop Valve.*

When thus equipped, a sudden reduction in pressure in any one of the boilers will cause the Lunkenheimer Non-return Safety Boiler Stop Valve attached to the boiler to instantly close, and isolate the disabled one from the others in the battery.

It thereby safeguards life and property and facilitates the safe and continued operation of the other boilers without loss of time.

It will also prevent steam being turned into a boiler that has been cut out for cleaning or repairs, as this valve cannot be opened by hand. And when placing a boiler in service it will not open until the boiler generates steam to the pressure in the steam main.

To play the game *safe,* specify "Lunkenheimer" and insist on their installation.

Our "Age of Safety" Booklet No. 525-DC will interest you. Write for a copy.

Lunkenheimer Steam Boiler Valves and Fittings are registered for use in Canada. Complete list of Registration Numbers will be sent on request.

THE LUNKENHEIMER CO.

"QUALITY"

Largest Manufacturers of High-Grade Engineering Specialties in the World

CINCINNATI, O., U.S.A.

New York Chicago Boston London

10-14-43

ESTABLISHED 1834

Look for the registered TRADE-MARKS

"WORLD"

OR

"McAVITY"

As a GUARANTEE of QUALITY

T. McAvity & Sons

Limited

Wholesale and Retail Hardware
Brass and Iron Founders

ST. JOHN, N.B.
CANADA

Branches at

MONTREAL, TORONTO, WINNIPEG, VANCOUVER
LONDON, ENGLAND

SAVE COAL!

USE

ECONOMIC BOILER COMPOUND

The cry for economy has gone through the land as a war necessity, so why not cut down your COAL CONSUMPTION. If you will send us a piece of scale from your boilers we will analyze same and send you our ECONOMIC BOILER COMPOUND, which we will guarantee to remove the scale from your boilers, or no pay for same.

ECONOMIC BOILER COMPOUND

Manufactured by

Canadian Economic Lubricant Company, Limited
MONTREAL

DIXON'S SOLID Belt Dressing

"Is The Perfect Belt Dressing"

Put up in handy sticks and applied while the belt is in motion.

By using Dixon's Belt Dressing every ounce of "pull" in a belt is quickly made available. Yet the composition of this dressing is such that it will not cause belts to crack or harden.

Better send for a free trial sample now.

Send for booklet 222-O.

Made in Jersey City, N.J., by the

JOSEPH DIXON CRUCIBLE COMPANY

ESTABLISHED 1827

Sole Canadian Representative:
CANADIAN ASBESTOS CO.
Montreal, Que.

MACHINERY FOR SALE

List of Machinery at Empire Tobacco Company, Granby; Prices are for Apparatus on Skids in Company's Yard.

	Machine	Maker	H.P.	Press	Size	Grate	Remarks	Price
H.R.	Tubular Boiler	W. C. White, Montreal	80	100	5'0"x14'0"	5'0"x5'0"	Installed 1900 single lap joints	$400.00
	"	Jenckes Machine Co., Sherbrooke, Que.	125	100	6'0"x16'0"	6'0"x6'0"	Installed 1905	800.00
	"	Jenckes Machine Co., Sherbrooke, Que.	125	100	5'6"x16'0"	5'6"x5'6"	Installed 1905	800.00

These boilers are without grates, but have fronts, gauges and cocks.

	Machine	Maker	H.P.	R.P.M.	Size	Pulley	Remarks	Price
(1)	Fan	Sheldon & Sheldon, Galt	8	480	48"			$ 34.00
(1)	Horizontal Corliss Valve Engine	Laurie Engine Co., Montreal	85	72	12"x36"	108"x16"	Installed 1905	600.00
(1)	Horizontal Slide Valve Engine	Robb Engineering Co.	12	200	6"x10"		Installed 1905	140.00
(1)	Horizontal Wheelock and Engine	Goldie & McCulough	55	65	10"x30"	96"x16"	Installed 1896	500.00

	Machine	Maker	Press	Size	Remarks	Price
(2)	Vertical Belt-driven Triplex Hydraulic Pump	John H. McGowan, Cincinnati	5000-lb.	1"x⅝"x3"	Installed 1900	$225.00
(1)	Horizon. Belt-driven Duplex Hydraulic Pump	Pontbriand & Freres, Ltd., Sorel	6000-lb.	¾x1½x2½	Installed 1907	75.00
(1)	Vertical Belt-driven Duplex Hydraulic Pump	Laidlaw, Dunn & Co., Cincinnati	3000-lb.	1¼x¾x4"	Installed 1895	140.00
	Vertical Triplex Hydraulic Pump	J. T. McGowan, Bliss.		1"x⅝x3"	Installed 1896	250.00
(1)	Fan—Height, 110"; base, 3'8½"x6'9½"; inlet, 3'0"-11"; outlet, 3'6"x3'0"; pulley, 22"x9½"; shaft, 2 9/16"; runner, 5' 6";				Sturtevant	350.00

APPLY

IMPERIAL TOBACCO CO. OF CANADA, LTD.
900 St. Antoine St., MONTREAL

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES

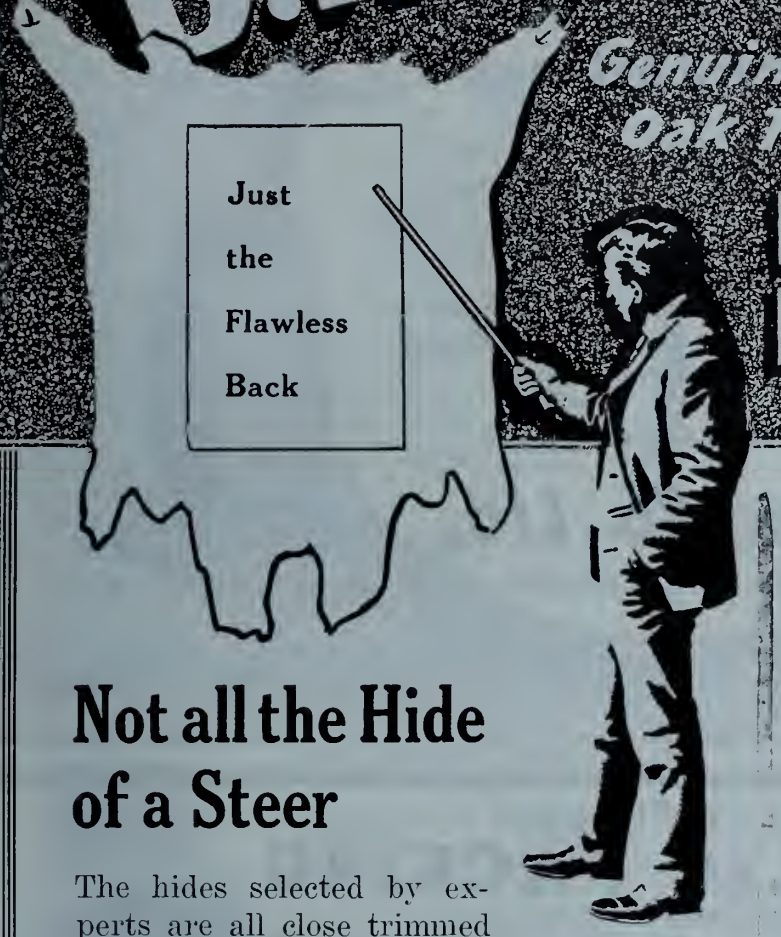
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog

W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

D.K.McLaren's

Genuine British Oak Tanned

LEATHER BELTING



Not all the Hide of a Steer

The hides selected by experts are all close trimmed before being exported—the only part of the hide good enough for D. K. McLaren's Leather Belting. Note illustration.

A slow, skill-demanding process is this.

Genuine British Oak Method of Tanning

It gives to the leather so much more toughness, durability and flexibility that we shall never turn from it to cheaper ways.

Consequently you are for all time guaranteed a remarkable saving in upkeep and renewal expense by using D. K. McLaren's Genuine British Oak Tanned Leather Belting.

Consider also its efficient delivery of power because of its slipless grip.

The largest power plants in Canada are users. *Write for references, prices and more facts.*

D·K·McLAREN LIMITED

TORONTO, ONT., 194 King St. West

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"Maple Leaf" Brand

Stitched Cotton Duck Belting

THE BEST FOR ALL KINDS OF BELTS

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.

Dominion Belting Co., Ltd.,

HAMILTON, CANADA

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Self-Lubricating

In Bulk

Pat. Dec. 22, 1903 — Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

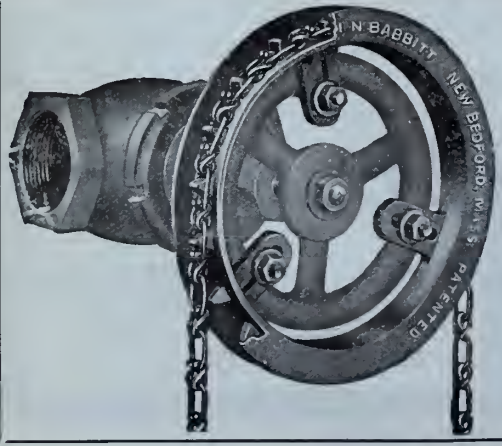
WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

Practically Frictionless

In Cotton Tubes



They Thought TWO Would Do

in a certain big New England mill, because mill and equipment were brand new and strictly modern.

But They've Bought Just 27 of These

Babbitt Adjustable Sprocket Rims

since July 1st. Like this: July 1, two; July 20, two; July 23, six; Aug. 25, eight; Sept. 8, nine. That's the way they go, because everybody recognizes them on sight, as "Just the thing they have been looking for, but did not know where to get it." Easy to put on—goes right on your present valve wheel—easy to pay for. Ask your dealer. Send for illustrated folder.

BABBITT STEAM SPECIALTY COMPANY

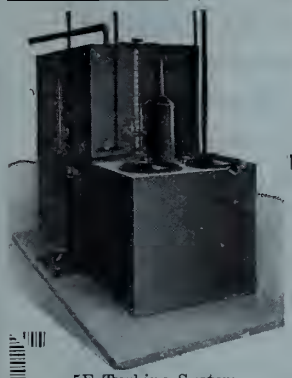
59 So. Water Street — NEW BEDFORD, MASS.

Manufactured in Canada, under Canadian patent by the Engineering Specialties Co., Ltd., 1080 King St. West, Toronto, Ont., Can.

ALBANY GREASE

is a most efficient, economical and dependable lubricant. It can be used, on account of its high lubricating qualities and its low melting point in any kind of grease cup and for every bearing in your plant. Use Albany Grease on your engines, pumps, compressors, motors, line shafting and special machines—always. We will gladly send you a quantity of Albany Grease to try and an Albany Cup. No charge of course. Write—now.

ALBANY LUBRICATING CO.
708-10 Washington Street, New York
ESTABLISHED 1868


5F Turbine System.

Suggestions *that* Lower Costs . .

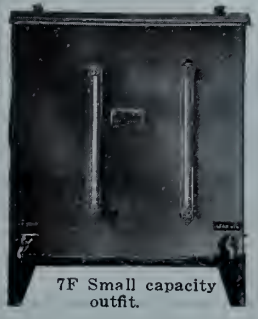
You cannot afford to overlook equipment that will reduce waste and operating expense, or increase production. Investigate the Bowser Oil Circulating and Filtering System, learn how it will prolong the life of machines, reduce coal consumption and repair bills by maintaining a steady flow of pure oil to every point of friction. Keeps oil pure and cool. No oil is lost.

BOWSER

Oil Circulating *and* Filtering Systems

Are built for any requirement, large or small. Their durability, simplicity and accuracy, also the ease of cleaning filter sections are "Reasons Why" Bowser Systems are in use in several of the largest plants in the country.

2F System.


7F Small capacity outfit.

Let us know your needs to-day.

S. F. BOWSER & CO., Inc.
Sales Offices in All Centres **Toronto, Ont.** Representatives Everywhere

Slip—or go through!

CASE 1—With a gripping surface of more than half its length, the tank is almost a part of the ground. It can't slip, for that would require more power than it does to move the load! Did you ever think of it that way?

CASE 2—Take the simple band brake, for instance: a strip of steel encircling a drum. When drawn down tight, all that outside surface is in contact, and the drum stops. Why? Because it takes more power to resist the brake than it does to stop the drum!

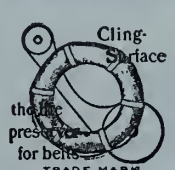
CASE 3—Consider the slack belt. The top side of the drive drops down on the two pulleys, increasing the arc of contact. It is harder for the belts and pulleys to slip than to carry the load, so they don't slip!

Here's a belt which has been running slack with CLING-SURFACE treatment for 12 years. Before CLING-SURFACE was used they were going to get a larger belt and bigger pulleys because this belt, run tight, slipped and would not pull the load. Instead, at a mere fraction of the cost, they treated it with CLING-SURFACE, prevented the slipping, and let it run slack. It now carries a 15% overload.

And that's exactly what the slack drive will mean for your belts—increased contact, more power delivered and slipping prevented.

All belts, and rope drives as well, on any centres, can be run easy or slack with CLING-SURFACE.

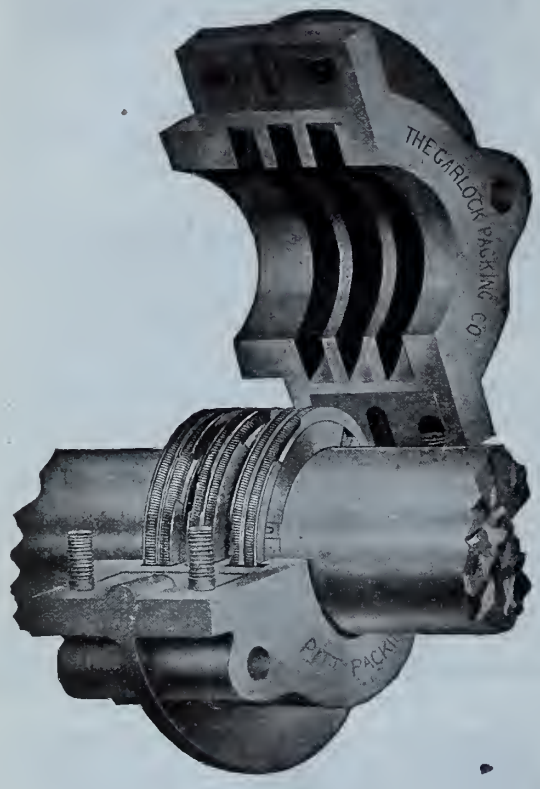
Send for a can for 60 days' trial. We will guarantee that you'll obtain these results BEFORE you pay for it. Isn't it worth the one-minute effort to you to have this increased power with absolutely trouble-proof drives? Then write to-day—tear out this ad and put it on the "to be answered" pile now.



Cling-Surface Co
1057 Niagara Street
Buffalo New York
U S A

GARLOCK

Metal Packing



Our position in the Metal Packing field is based on the principle that "No one style of metal packing can be made to meet all conditions." Our experts study carefully the conditions surrounding each case to determine which type of packing is best suited to the conditions.

The accompanying illustration shows our Flexible Packing, with split case, which is the best all-around packing for stationary work, and when recommended by us to meet stated conditions it is guaranteed to give satisfactory service. This style is also made with solid or split case to fit inside of stuffing box, when packing space is sufficient to permit inside application of case and segments. Next to correct mechanical design the most important feature of metal packing is the material used in the bearing rings. Our materials are made from formulas which long experience has shown to give the best results. A special grade of cast iron is generally used for bearing segments, in order to secure minimum wear and friction, but under unusual conditions, or when considerable condensation enters stuffing box, bronze rings or segments of softer metal have to be used in the wearing parts. We can solve your metal packing problems, and we will give the usual Garlock guarantee of satisfactory service, if conditions are such as will admit of the successful use of any metal packing. Write for catalog describing our many styles of metal and fibrous packings.

The Garlock Packing Company - Hamilton, Ont.

Branches:

Montreal, Quebec - - - - 409 Shaughnessy Building
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Omalley-Beare Valve

3 or 4 Renewal Plates
on Head.

3 or 4 Renewal Plates
on Seat.

NO REGRINDING.

If Valve Leaks, Remove
Worn Plates

PRESTO!

a New Valve.

FOR PHOSPHATE PLANTS

LAKELAND PHOSPHATE COMPANY,
Lakeland, Fla.

Magnolia Metal Co.,
New York City.

Nov. 4, 1916.

Gentlemen,—I have been a user of Magnolia Metal for a number of years, using it in the kaolin and phosphate business, and have always found it to give better results than any other frictionless metal that I have used, and always specify it for repairs and new equipment.

Yours very truly,
G. C. Long, Chief Engineer.

PRACTICAL ENGINEER POCKET BOOK:
Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
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SOLD BY LEADING DEALERS EVERYWHERE OR BY
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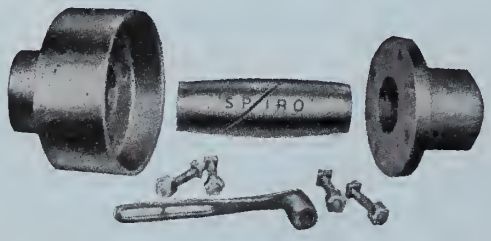
The Spiro Never Slips

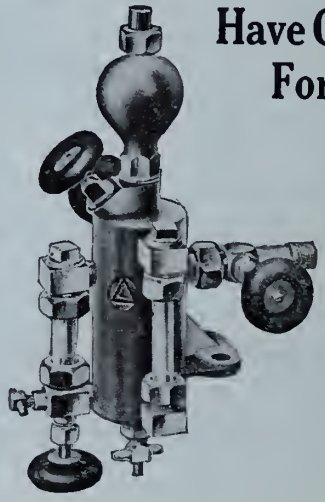


The Spiro Compression Coupling is locked to the shaft by a graduated grip.
The pull of the bolts on the two halves of the coupling acts on the spiral slotted sleeve until it grips the full surface of the shaft with a never-slip hold.
Every bolt pulls, and at every pull the grip grows.
And last, but not least, the Spiro can be removed as quickly and easily as it can be applied.
The Bond Booklet describes our complete line of Power Transmission Devices.

Canadian Bond Hanger & Coupling Company, Limited
Alexandria Ontario

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

The Joints of Morse Rocker-Joint Silent Chains

THE "ROCKER-JOINT" was devised over twenty years ago, long before the era of silent chains, as a scientific principle for eliminating frictional losses. It was immediately recognized throughout the mechanical world as *the one perfect joint.* The MORSE CHAIN CO. was the first to adapt this "ROCKER" principle to a chain joint, and the patent laws of every civilized country prevent its use on any other chain. Chain manufacturers everywhere have attempted to find a substitute for the "ROCKER" principle—some other principle which would also do away with the friction of the ordinary joint. But to this day the "ROCKER-JOINT" STANDS ALONE, the only chain joint which eliminates *destructive sliding friction.*

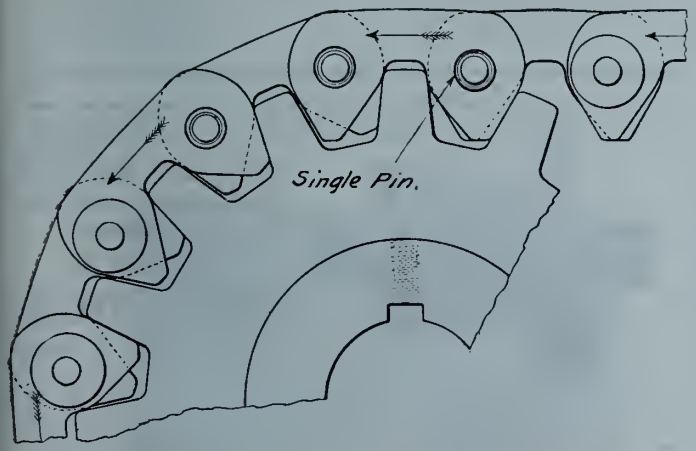


Fig. 1. The ordinary chain bending over the sprocket.

The ordinary silent chain joint is formed by a round hole at each end of each link, through which runs a round pin holding the rows of links together. This pin forms the axis about which the links twist in bending over the sprocket teeth. Obviously, as the load on the chain increases, the sliding friction on this single pin and on the holes of the link increases. A plentiful supply of lubricant and hardened bushings are essential to this joint and at best, wear and loss of power are certain.

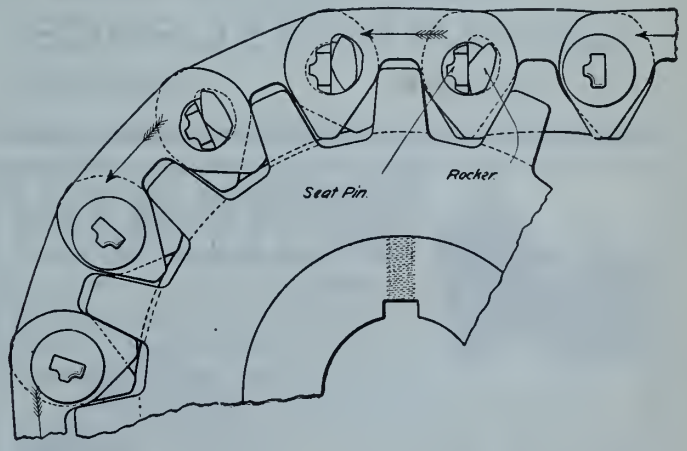


Fig. 2. The "Rocker-Joint" on the sprocket.

The "Rocker-Joint" is formed by two special, case-hardened steel pins, both of them seated in the holes of the links, the seat pin in the row of links to the right of the joint, and the Rocker pin in the row to the left. As the chain bends in circling around a sprocket, the curved side of the Rocker pin rolls or rocks upon the broad, flat side of the Seat pin. THIS IS THE ONLY MOVEMENT IN THE JOINT. There being no action between the hardened pins and the softer edges of the hole, bushings are unnecessary.

The "ROCKER-JOINT" depends upon its construction, not upon lubricant, for its life and efficiency.

MORSE CHAIN CO., Ithaca, N.Y.

The Largest Manufacturers of Silent Chains in the World

BUY VICTORY BONDS—SAFEST INVESTMENT IN CANADA TO-DAY.

HINTS TO BUYERS

DOMINION COAL COMPANY LIMITED

"Dominion" and "Springhill" BITUMINOUS STEAM and GAS COALS

GENERAL SALES OFFICE

112 St. James St. Montreal

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways.
W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

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THE GARTH COMPANY
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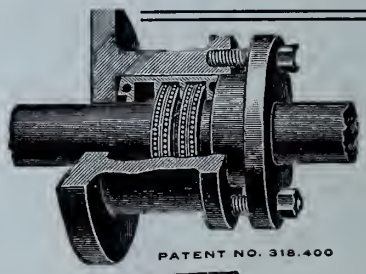
WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.



PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	654,541	" "	878,238
" "	654,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775,193	" "	905,103
" "	775,194	" "	934,629
" "	791,300	" "	979,208
" "	805,669	" "	1000,75

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing

Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.
Incorporated 1897

Water Turbines, Hydraulic Governors, Centrifugal Pumps

OUR LINDSAY WORKS

Boving Hydraulic & Engineering Co., Limited
LINDSAY, ONTARIO

THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa,
Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914, With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

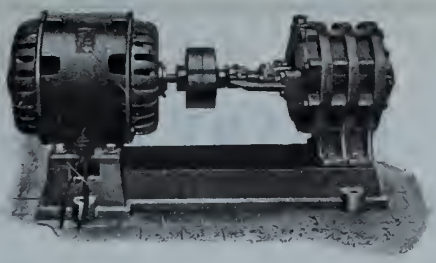
Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

HON. F. G MACDIARMID, Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D., Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.



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The Smart-Turner Machine Co., Limited
HAMILTON, CANADA

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Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

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COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The Uehling CO_2 Recorder makes a complete 24 hr. record of your combustion efficiency and the CO2 indicator at the Boiler Front holds the fireman responsible.

Get more Steam per pound of Coal and reduce your annual fuel consumption.

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

CO2 Indicator for Boiler Front

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

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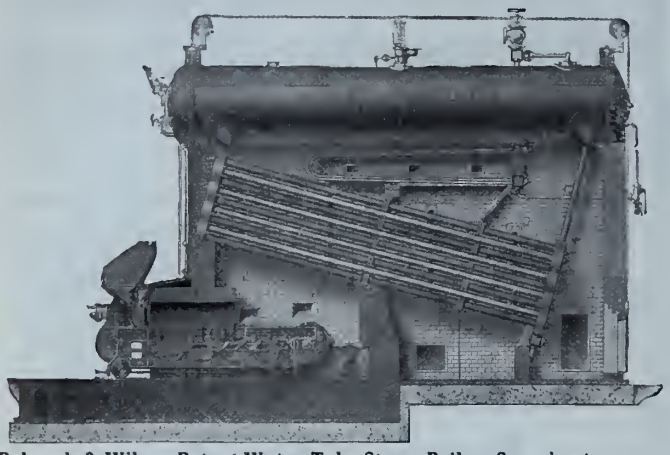
2008 Empire Building New York City

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 17,000,000 H.P. IN U



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Steam Superheaters
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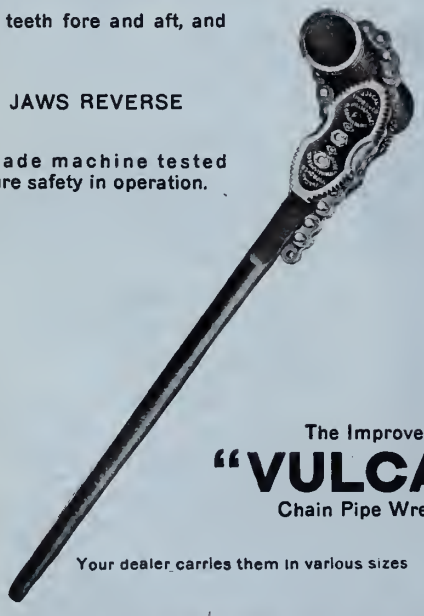
LIKE IMMORTAL JANUS
Double Faced

See their teeth fore and aft, and remember

THEIR JAWS REVERSE

Hand made machine tested chains insure safety in operation.



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"VULCAN"
Chain Pipe Wrench

Your dealer carries them in various sizes

J.H.WILLIAMS & CO.
THE WRENCH PEOPLE
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The Wrench of 25% Greater Efficiency

TRIMO PIPE WRENCH

Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

The inserted jaw in the handle can be readily replaced when worn, thus adding to the life of the tool.

Nut with Nut-Guards

Inquiries from Importers and Dealers Solicited. Send for Catalogue No. 55.

TRIMONT MANUFACTURING CO.

Cable Address: Triwrench
Code; Western Union

Roxbury (Boston) Mass., U.S.A.

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BLOWERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Can. Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnston St., Newark, N.J.
Coppus Eng. & Equip. Co., Worcester, Mass.
Sturtevant Co. of Canada, Ltd., B. F., Galt, Ont.

BOILER COMPOUNDS
Beveridge Paper Co., Ltd., Montreal, Que.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

BOILER COMPOUND FEEDERS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Morehead Mfg. Co., Woodstock.
Lunkenheimer Co., Cincinnati, O.

BOILER FEED PUMPS
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

BOILER FEED REGULATORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Mason Regulator & Engineering Co., Montreal.

BOILER GRAPHITE
Joseph Dixon Crucible Co., Jersey City, N.J.

BOILER MOUNTINGS
Babcock & Wilcox, Ltd. Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.

BOILER HOUSE ACCESSORIES
Babcock & Wilcox, Ltd. Montreal.
Canadian Griscom-Russell Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Engineering Co., Montreal.

BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

BOILER TUBE CLEANERS
Babcock & Wilcox, Ltd. Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg.
Laurie & Lamb, Montreal.

BOILERS, HORIZONTAL, RETURN, TUBULAR AND WATERTUBE
Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
Jones Underfeed Stoker Co., Toronto.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Ladd, The Geo. T., Co., Pittsburgh, Pa.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

BOILERS, MARINE, LOCOMOTIVE AND VERTICAL
Babcock & Wilcox, Ltd. Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
John McDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford, Ont.

BOOKS
MacLean Publishing Co., Toronto.

BRASS FOUNDERS
McAvity, T., & Sons, Ltd., St. John, N.B.
D'Este Co., Julian, Boston, Mass.

BRINE COOLERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford, Ont.
York Manufacturing Co., York, Pa.

BUSHINGS
Steel Mill Packing Co., Windsor, Ont.

CALORIMETERS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

CANS, OILY WASTE
Jas. Morrison Brass Mfg. Co., Toronto.

CAST IRON FITTINGS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

CASTINGS, BRASS AND IRON
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Lunkenheimer Co., Cincinnati, O.
John McDougall Caledonian Iron Works Co., Ltd., Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

CEMENT, HIGH TEMPERATURE
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

CEMENT MACHINERY
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Waterous Engine Works Co., Brantford, Ont.

CHAIN DRIVES
Morse Chain Co., Ithaca, N.Y.

CHAIN WHEELS
Babbitt Steam Specialty Co., New Bedford, Mass.

CHIMNEYS, STEEL
Babcock & Wilcox, Ltd. Montreal.

CHUTES, COAL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

CLOCKS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Foxboro Co., The, Foxboro, Mass.

CLUTCHES
Waterous Engine Works Co., Brantford, Ont.

COAL
Dom. Coal Co., Montreal.

COAL AND ASH CONVEYORS
Babcock & Wilcox, Ltd. Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford, Ont.

COAL HANDLING MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

COAL HOLE COVERS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

COILS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

COLD STORAGE INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

COMMUTATOR TRUING DEVICES
Jordan Bros., Inc., New York, N.Y.

CONDENSERS
Alberger Heater Co., Buffalo, N.Y.
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Belliss & Morcom, Birmingham, Eng.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Ltd., Montreal, Que.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Wks., Montreal.
Waterous Engine Works Co., Brantford.

CONDENSERS, AMMONIA AND STEAM
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

COLLECTORS, PNEUMATIC
Sturtevant Co. of Canada, B. F., Galt, Ont.

CONSULTING ENGINEERS
Walter J. Francis, Montreal.
Laurie & Lamb, Montreal.

COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

COMPRESSORS, AIR
American Steam Pump Co., Battle Creek, Mich.
Beliss & Morcom, Birmingham, Eng.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Smart-Turner Machine Co., Ltd., Hamilton.

COMPRESSORS, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

CONDUITS
Can. H. W. Johns-Manville Co., Toronto, Ont.

CONDENSATION RECEIVER
Cole, Ltd., Geo. W., Toronto.
G. M. Davis Regulator Co., Chicago.

CONNECTIONS, FLANGED
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

CONTRACTORS' STRUCTURAL STEEL
Canadian Fairbanks-Morse Co., Ltd. Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.

CONVEYOR MACHINERY
Babcock & Wilcox, Ltd. Montreal.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Canadian Fairbanks-Morse Co., Ltd. Montreal.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

COOLER, DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

CORK INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

COTTON HOSE
Garlock Packing Co., Hamilton, Ont.

COUNTERS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

COUNTERSHAFTS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.

COUPLINGS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jeffrey Manufacturing Co., Montreal.
McAvity & Sons, T., St. John, N.B.

COUPLINGS, BOILER, FLANGED PIPE, JOINT PIPE, UNION, STEAM PIPE
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

COUPLINGS, SHAFT
Can. Bond Hanger & Coupling Co., Alexandria, Ont.

CRANES, ALL KINDS
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, ELECTRIC
Babcock & Wilcox, Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, HAND POWER
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, OVERHEAD TRAVELLING
Babcock & Wilcox, Ltd., Montreal.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

CRANES, POST JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, SWING JIB
Babcock & Wilcox, Ltd., Montreal.

CRANES, WALL
Babcock & Wilcox, Ltd., Montreal.

CRANK AND CROSSHEAD PIN OILERS
Lunkenheimer Co., Cincinnati, O.

CRIMPS, LEATHER
Graton & Knight Mfg. Co., Montreal.

CRUSHING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.

CYLINDER OIL
E. H. Kellogg & Co., New York.

DAMPER REGULATORS
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Darling Bros., Ltd., Montreal, Que.
G. M. Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Mason Regulator Co., Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.

DISCS, FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.

DISCS, LEATHER
Graton & Knight Mfg. Co., Moutreal.

DISTILLING APPARATUS
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DOORS, COLD STORAGE AND FREEZER
Jamison Cold Storage Door Co., Hagerstown, Md.

DOUBLE PIPE CONDENSERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

DRYING MACHINERY
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Sirocco Co., Windsor, Ont.

DUST SEPARATORS
Sturtevaut Co. of Canada, B. F., Galt, Ont.

DYNAMOS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Sturtevant Co. of Canada, B. F., Galt, Ont.

ECONOMIZERS
Babcock & Wilcox, Ltd., Montreal.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Green Fuel Economizer Co., New York, N.Y.

EJECTORS
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Ltd., Hamilton.

ELECTRICAL ACCESSORIES AND MACHINERY
Can. H. W. Johns-Manville Co., Toronto, Ont.
Beveridge Paper Co., Ltd., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Economy Fuse & Mfg. Co., Montreal, Que.
MacGovern & Co., Inc., New York.

ELECTRICAL SUPPLIES
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

ELEVATORS
MacKinnon, Holmes & Co., Sherbrooke Ont.
John MacDougall Caledonian Iron Works, Montreal.

ELEVATING MACHINERY
Canadian Fairbauks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

ENGINEERS' SUPPLIES
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Ltd., Montreal, Que.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.
Jas. Morrison Brass Mfg. Co., Toronto.

ENGINES, AUTOMATIC AND DROP VALVE
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford.

ENGINES, CORLISS AND ROCKING VALVE
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

ENGINES, DIESEL
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, GAS AND GASOLINE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Out.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

ENGINES, STEAM
Belliss & Morcom, Birmingham, Eng.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Can. Sirocco Co., Windsor, Ont.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
John MacDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, HOISTING, LOGGING, CABLEWAY
Can. Allis-Chalmers, Ltd., Toronto, Ont.

ENGINES, MARINE
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.

ENGINES, SAW MILL
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
Waterous Engine Works Co., Brantford.

ENGINES, SINGLE COMPOUND AND TRIPLE EXPANSION
Canadian Griscom-Russell Co., Ltd., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
Laurie & Lamb, Montreal.
John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Kerr Engine Co., Walkerville.
Waterous Engine Works Co., Brantford.

ENGINES, VERTICAL
Laurie & Lamb, Montreal.

ENGINEERING BOOKS
MacLean Publishing Co., Toronto.

EXHAUST HEADS
Can. Sirocco Co., Windsor, Ont.
Darling Bros., Ltd., Montreal, Que.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Watson & McDaniel Co., Philadelphia.

EXPANSION JOINTS
Alberger Heater Co., Buffalo, N.Y.
Direct Separator Co., Syracuse, N.Y.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FANS, VENTILATING
Can. Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Coppus Engr. & Equip. Co., Worcester, Mass.
Green Fuel Ecouomizer Co., New York, N.Y.
Sturtevant Co. of Canada, B. F., Galt, Ont.

FEED WATER HEATERS
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Stewart Heater Co., Buffalo, N.Y.
Waterous Engine Works Co., Brantford.

FEED WATER PURIFIERS
Stewart Heater Co., Buffalo, N.Y.

FEED WATER REGULATORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Chaplin, Fulton Mfg. Co., Pittsburg, Pa.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.

FILTERS
Bowser & Co., Inc., S. F., Toronto, Ont.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.

FILTERS, WATER
Canadian Griscom-Russell Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Frick Co., Waynesboro, Franklin Co., Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
York Manufacturing Co., York, Pa.

FIRE BRICK, PLASTIC
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

FIREPROOF COLD STORAGE DOORS AND WINDOWS
Jamison Cold Storage Door Co., Hagerstown, Md.

FITTINGS, AIR, AUTOMOBILE, GAS, HYDRAULIC, PIPE, PIPE FLANGED, SCREWED PIPE, STEAM
Jefferson Union Co., Lexington, Mass.
Dart Union Co., Ltd., Toronto, Ont.

FLANGED STEAM FITTINGS
Direct Separator Co., Syracuse, N.Y.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLANGES
Dart Union Co., Ltd., Toronto, Ont.
Jefferson Union Co., Lexington, Mass.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

FLOORING COMPOSITION
Armstrong Cork & Insulation Co., Montreal, Que.

FLUE CLEANERS
Babcock & Wilcox, Montreal.
Liberty Mfg. Co., Pittsburg, Pa.
William B. Pierce Co., Buffalo, N.Y.

FLUE GAS ANALYSIS INSTRUMENTS
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York.
Precision Instrument Co., Detroit, Mich.
Penberthy Injector Co., Windsor, Ont.

FLUMES, STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

FREEZER DOORS
Jamison Cold Storage Door Co., Hagerstown, Md.

FRICTION LEATHERS
Graton & Knight Mfg. Co., Montreal.

FURNACES, BOILER
Gates, J. W., Montreal, P.Q.

FURNACES, SMOKELESS
Babcock & Wilcox, Montreal.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Detroit, Mich.

FUSES
Can. H. W. Johns-Manville Co., Toronto, Ont.
Economy Fuse & Mfg. Co. of Canada, Montreal.

GAS ANALYSIS INSTRUMENTS, ETC.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GASKETS, RUBBER, ASBESTOS, LEAD, COPPER AND LEATHER
Can. H. W. Johns-Manville Co., Toronto, Ont.
Durabla Mfg. Co., New York, N.Y.
Frick Co., Waynesboro, Franklin Co., Pa.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

GAS COLLECTORS
Precision Instrument Co., Detroit, Mich.

GAS PRODUCER PLANTS
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Laurie & Lamb, Montreal.

GAUGE COCKS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
W. J. Wall, Montreal.

GAUGES, AMMONIA, OIL, GAS, AIR
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GAUGES, PRESSURE, VACUUM, DRAFT AND RECORDING, AND MICROMETER
Babcock & Wilcox, Montreal.
Foxboro Company, Foxboro, Mass.
Lunkenheimer Co., Cincinnati, O.
Precision Instrument Co., Detroit, Mich.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

GAUGES, WATER
Babcock & Wilcox, Montreal.
Jenkins Bros., Ltd., Montreal.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Penberthy Injector Co., Windsor, Ont.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

GEARS, FIBRE CUT
Beveridge Paper Co., Ltd., Montreal, Que.

GEARS, CUT, WORM, MORTISE
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

GENERATORS, STEAM TURBO
Can. General Electric Co., Toronto, Ont.
Laurie & Lamb, Montreal.

GENERATORS AND CONVERTORS
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. General Electric Co., Toronto, Ont.

GOVERNORS, ENGINE
Escher Wyss & Co., Montreal, Que.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford.

GRAPHITE, BOILER
Jos. Dixon Crucible Co., Jersey City.

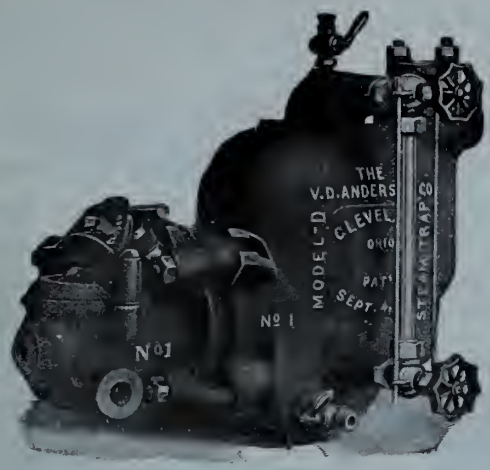
GRATES, DUMPING, ROCKING, STATIONARY
Babcock & Wilcox, Montreal.
Boiler Repair & Grate Bar Co., Toronto, Ont.
Ed. Bennis & Co., Little Hulton, Bolton, Eng.
C. T. Coe Co., 10 Johnson St., Newark, N.J.
Galt Foundry Co., Galt, Ont.
Mason Regulator & Engineering Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.
Waterous Engine Works Co., Brantford.

GREASE CUPS
Albany Lubricating Co., New York City.
Detroit Lubricator Co., Walkerville.
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

GREASE AND OIL EXTRACTORS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Griscom-Russell Co., Ltd., Montreal.
Elliott Co., Pittsburgh, Pa.
Laurie & Lamb, Montreal.

GREASES
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Jos. Dixon Crucible Co., Jersey City.

HAND LEATHERS OR PADS
Graton & Knight Mfg. Co., Montreal.



Steam Trap

Points of Interest—

Self-contained strainer and sediment chambers.

Outside gauge glass furnishes evidence as to inside efficiency.

Three-inch water seal.

Counterbalanced seamless Lake Superior copper float.

Steam leaks stopped.

Can be adjusted to 60 lb. coil in the vacuum pans or a 160 lb. main to protect the engine.

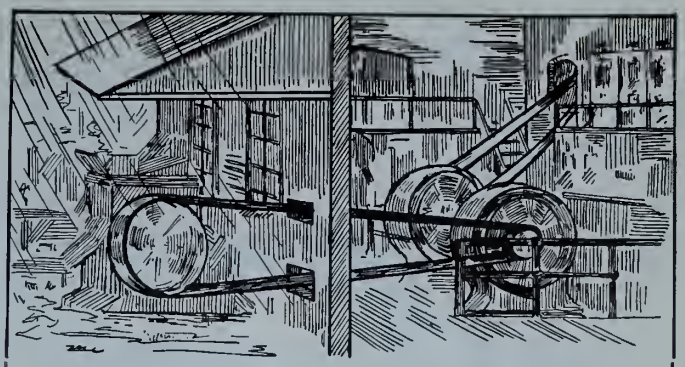
Used on any steam apparatus at pressures varying from 250 lbs. to gravity.

Used where there is any condensation in air lines.

Some points that explain why the Anderson Steam Trap is leading in the field of service. If you are troubled with condensation or any boiler room trouble, get in touch with us and secure our co-operation.

The V. D. Anderson Co.

1935 West 96th St.
Cleveland, Ohio



LANCO BALATA BELTING

From WET to DRY

Impregnated with Balata gum, Lanco Balata Belting is rendered proof against the penetration of water. This "Lanco Impregnation" of the most powerful, non-stretching fabric—long staple cotton duck tightly woven by our special process—gives you a belting that will serve longest under all but one atmospheric condition. The one exception is heat.

In service, Lanco Balata is as nearly stretchless as a good belt can be made. Use it wherever conditions constantly change from wet to dry.

Write to-day for our Belting Book.

Federal Engineering Co., Limited
172 John St., Toronto

Morehead
Back to Boiler
SYSTEM

60,000,000 Tons of Coal Thrown Away Yearly

Over 600,000,000 tons of coal are mined yearly in the United States and Canada. Ten per cent. of that enormous production is carelessly, needlessly wasted. Over Sixty Millions of Dollars are spent each year in producing—nothing, and yet, a mere fraction of that great loss, if properly applied, would save those wasted millions for years to come.

You are contributing to this national waste—but you can stop it.

Steam, after its expansive energy is exhausted, is not through with its job. There are heat units left—live, tangible heat units which were purchased by coal at the boiler's mouth.

What Are You Doing With These Heat Units?

This condensation, in other words.

With the Morehead System installed on your steam lines the condensation is automatically returned to the boiler—without pumps—and at any temperature. It is the last link from boiler back to boiler—the unused energy is not wasted.

If you would save this ten per cent. and have a clear steam system which drains automatically, write to-day for particulars.

CANADIAN MOREHEAD MFG. CO.
Woodstock, Ontario

HANGERS
Can. General Electric Co., Toronto, Ont.
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Can. S K F Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

HEATERS
Alberger Heater Co., Buffalo, N.Y.
Babcock & Wilcox, Ltd., Montreal.
Can. Sirocco Co., Windsor, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Waterous Engine Works Co., Brantford.

HEATERS, EXHAUST STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATERS, METERING
Can. Allis-Chalmers, Ltd., Toronto, Ont.

HEATING SYSTEMS, FANS
Can. Sirocco Co., Windsor, Ont.

HOISTS, GRIP
Jordan Bros., Inc., New York, N.Y.

HOISTING AND CONVEYING MACHINERY
Babcock & Wilcox, Ltd., Montreal.
Waterous Engine Works Co., Brantford.

HOSE, METALLIC
Pennsylvania Flexible Metallic Tubing Co., Boston, Mass.

HOSE, STEAM, SUCTION AND WATER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Asbestos Co., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Peerless Rubber Mfg. Co., New York, N.Y.

HYDRAULIC ACCUMULATORS
Smart-Turner Machine Co., Ltd., Hamilton.

HYDRAULIC MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
John McDougall Caledonian Iron Wks., Montreal.

HYDRAULIC PRESSES
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

ICE MAKING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co.
Linde Canadian Refrigeration Co., Montreal.
York Mfg. Co., York, Pa.

INDICATORS, ELECTRIC—ALL TYPES
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
Uehling Instrument Co., New York, N.Y.

INDICATORS, STEAM AND GAS ENGINE
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Canadian Fairbanks-Morse Co., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Uehling Instrument Co., New York, N.Y.

INDICATORS—AMMONIA, HYDRAULIC
Can. Detroit Lubricator Co., Walkerville, Ont.

INDICATORS, SPEED
L. S. Starrett Co., Athol, Mass.

INJECTORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

INSULATING BRICK
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATORS
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Beveridge Paper Co., Ltd., Montreal, Que.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, NITRO
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LUBRICANTS
Albany Lubricating Co., New York City.
Canadian Economic Lubricant Co., Montreal.
Jos. Dixon Crucible Co., Jersey City.

LUBRICATORS, CYLINDER
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.

METERS, WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Foxboro Company, Foxboro, Mass.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Precision Instrument Co., Detroit, Mich.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Torouto, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL CUPS
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cinciunati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Ciucinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL SEPARATORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILING SYSTEMS
Albany Lubricating Co., New York City.
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, LUBRICATING
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Kellogg & Co., E. H., New York, N.Y.

PACKING ENGINE
Can. Asbestos Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. B. K. Morton Co., Toronto, Montreal.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.

PACKING, HYDRAULIC
Can. Asbestos Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. B. K. Morton Co., Toronto, Montreal.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.

PACKING, AMMONIA, STEAM AND WATER
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Goodyear Tire & Rubber Co., Toronto.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Can. B. K. Morton Co., Toronto, Montreal.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd, Toronto, Ont.

PAINT, DAMP RESISTING
Toch Bros., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Waterous Engine Works Co., Brantford.

PIPE COILS
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.

PLATE WORK
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.

POWER, TRANSMISSION MACHINERY
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
MacGovern & Co., New York.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Out.

PRESSURE, BLOWERS, CENTRIFUGAL
Can. Sirocco Co., Windsor, Ont.

PULLEYS
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Wm. Hamilton Co., Ltd., Peterboro.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULP MILL MACHINERY
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Bawden Machine Co., Toronto.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich
Bawden Machine Co., Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Storey Pump & Equipment Co., Ltd., Toronto.

PUMPS, CONTRACTORS'
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.

PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.

The Vigilant

Feed Water Regulator is a perfected device that constantly

Keeps Water Level Within ¼ inch of Middle Gauge

Other devices may almost equal the Vigilant for a time. But with them you will learn all too soon that floats become water-logged, leaky or collapse in spite of guarantees to the contrary.

The Vigilant has but few parts and **no floats.** It gives no trouble. Throughout its long life it will provide absolute prevention from dangers of high or low water.

It will also reduce your coal bill from 3 to 17 per cent.

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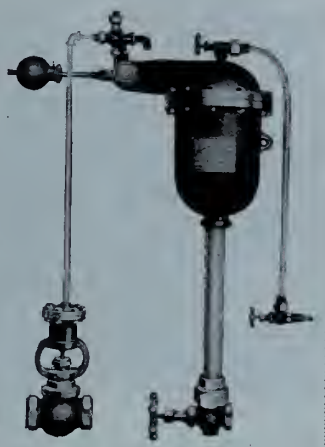

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28 Penn Ave., Pittsburgh, Pa.

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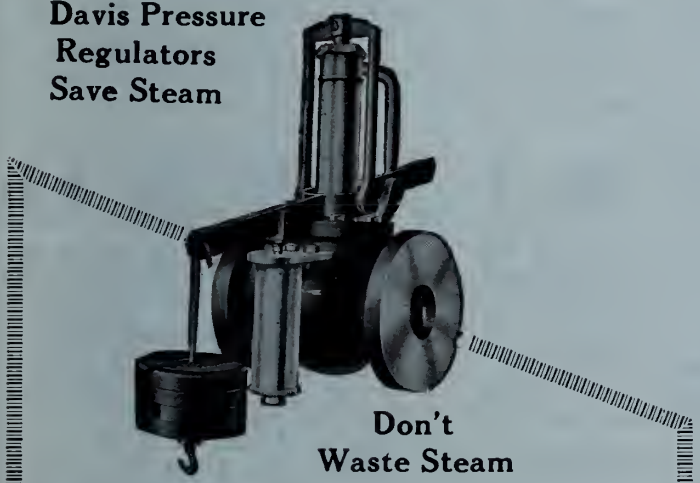

Don't Waste Steam

You carry high boiler pressure for emergencies and peak loads, but are you sure this reserve is not slipping away? You know only too well the cost of coal —conserve it by keeping your steam pressure under full control with

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Put these automatic valves to work wherever you can use less than boiler pressure. The cost is trifling and the saving big. Forty years on the market is enough to prove they are built right. Send for catalog. It will show you a way to cut costs.

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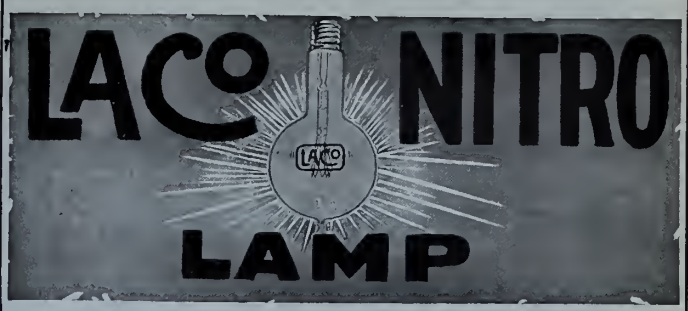

LIGHT IS AN ASSET

The benefits of sunlight are thrust upon you, but you yourself must acquire the advantages of proper artificial lighting.

In thousands of power stations, sub-stations, factories, mills and offices, the real money-saving value of efficient artificial lighting is already appreciated and good light is considered an asset and production increaser.

In daytime skilled labor and high priced assistants perform their duties with accuracy and precision, but are you handicapping them during the dark hours and night shift by giving them insufficient artificial light?

Protect them against accidents and error risks and make their working vicinity bright and cheerful by using

LACO NITRO LAMP "THE LIGHT THAT GIVES MORE LIGHT"

This lamp is gaining daily in popularity because of its many superior merits over other type lamps.

Low in operating cost and high in efficient service. Uses less current and gives a clearer, brighter light than heretofore possible. Scientifically constructed with tungsten filament substantially suspended in nitrogen gas-filled bulb, thus securing long utility under severe usage.

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Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
Watson & McDaniel Co., Philadelphia.
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Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Liberty Mfg. Co., Pittsburgh, Pa.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Pulsometer Engineering Co., Ltd., London, Eng.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Waterous Engine Works Co., Brantford.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Moutreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
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Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Toronto, Montreal.
Graton & Knight Mfg. Co., Montreal.
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Bawden Machine Co., Ltd., Toronto.
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, STEAM TURBO
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
Pulsometer Engineering Co., Ltd., London, Eng.
PUMP TANK, RECEIVER
American Steam Pump Co., Battle Creek, Mich.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PYROMETERS
Foxboro Co., The, Foxboro, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
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Uehling Instrument Co., New York, N.Y.
RADIATOR TRAPS
Sarco Co., Inc., New York, N.Y.
RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
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REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
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Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto, Ont.
Foxboro Co., The, Foxboro, Mass.
Precision Instrument Co., Detroit, Mich.
Uehling Instrument Co., New York, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Canadian Griscom-Russell Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
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Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
REGULATORS, TEMPERATURE
Sarco Co., Inc., New York, N.Y.
RETORTS
MacKinnon, Holmes & Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
ROPE PRESERVATIVE
Cling Surface Co., Buffalo.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg, Pa.
RUBBER MOLDS
Bawden Machine Co., Ltd., Toronto.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
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Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
William B. Pierce Co., Buffalo, N.Y.
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National Boiler Protector Co. of Canada, Montreal, Que.
SHAFTING
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
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Galt Foundry Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
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Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
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Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
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Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPLICE PROTECTORS
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SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.
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Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
STAND PIPFS, STEEL
MacKinnon, Holmes & Co., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
STEAM SEPARATORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor.
Smart-Turner Machine Co., Hamilton, Ont.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Watson & McDaniel Co., Philadelphia.
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Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Can. Sirocco Co., Windsor, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Davis Regulator Co., G. M., Chicago.
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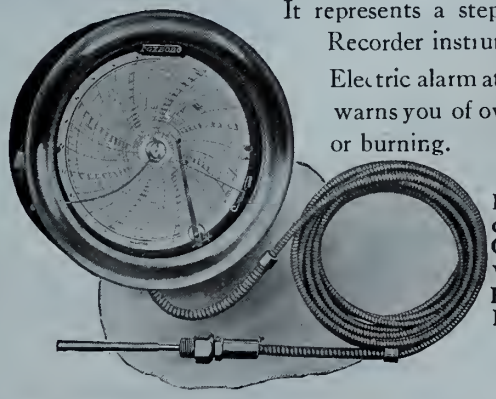

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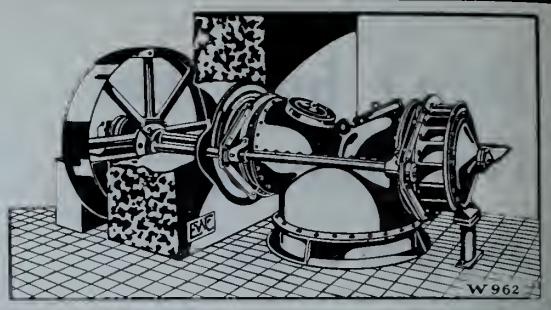

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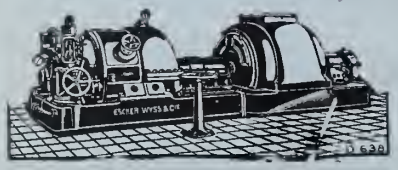

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62-17

INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 71
Alberger Heater Co. 52
American Steam Gauge & Valve Mfg. Co. 50
American Steam Pump Co. 64
Anderson Co., V. D. 81
Armstrong Cork Insulation Co. 11
Audel & Co., Theo..... 85

B

Babbitt Steam Specialty Co... 70
Babcock & Wilcox 78
Bennis & Co., Ltd., Ed..... 4
Beveridge Paper Co. 86
Boiler Inspection Dept..... 77
Boving Hydraulic & Eng. Co... 76
Bowser, S. F., & Co., Inc..... 71

C

Can. Allis-Chalmers, Ltd. 59
Can. Assoc. Stationary Engrs.. 60
Can. Bond Hanger & Coupling Co. 74
Can. Detroit Lub. Co. 74
Can. Economic Lubricant Co.. 68
Can. Fairbanks-Morse Co. 49
Can. Laco-Philips Co. 83
Can. H. W. Johns-Manville Co., Ltd. 9
Can. Morehead Mfg. Co. 81
Can. Sirocco Co. 87
Can. S K F Co. 53
Canuck Supply Co., Ltd..... 73
Chaplin-Fulton Co. 83
Cling-Surface Co. 71
Coe Co., C. T. 61
Cole, Geo. W. 47
Coppus Eng. & Equip. Co.... 6

D

Darling Bros. 66
Dart Union Co. 63
Davis Regulator Co. 83

PAGE

D'Este Co., Julian 66
Direct Separator Co. 54
Dixon Crucible Co., Jos..... 68
Dominion Belting Co. 70
Dominion Coal Co. 76
Durabla Mfg. Co. 50

E

Economy Fuse & Mfg. Co. of Canada 4
Elliott Company 43
Escher Wyss & Co. 88

F

Federal Engineering Co. 81
Foxboro Co. 87
Francis, Walter J., & Co..... 48
Frick Co. 11

G

Galt Foundry Co. 5
Garlock Packing Co. 72
Garth Co. 76
Gates, John W. 46
Goldie & McCulloch Co..... 16
Goodyear Tire & Rubber Co.. 8
Graton & Knight Mfg. Co.... 55
Greene, Tweed & Co..... 51

H

Holmes Metallic Packing Co... 76
Homestead Valve Mfg. Co.... 66
Hoyt Metal Co. 2

I

Imperial Tobacco Co. of Can., Ltd. 68
Inglis Co., John. Inside back cover

J

Jamison Cold Storage Door Co. 12
Jefferson Union Co. 65
Jeffrey Mfg. Co. 62

PAGE

Jenckes Machine Co. 4
Jenkins Bros. 57
Jones Underfeed Stoker Co., Ltd. 2
Jordan Bros., Inc. 77

K

Kellogg & Co., E. H..... 48
Kerr Engine Co. 64

L

Ladd Co., The Geo. T..... 76
Laurie & Lamb 13
Leitch Co., The Arthur S..... 6
Linde Canadian Refrigeration Works Co. 10
Long, J. T. 46
Lunkenheimer Co. 67

M

MacGovern & Co. 87
MacKinnon, Holmes & Co.... 48
MacLean's Magazine 56
Magnolia Metal Co. 74
Mason Regulator Co. 6
Mason Regulator & Eng. Co., Ltd. 7
McAvity & Sons, T..... 67
McDougall Caledonian Iron Works Co. 14
McGhie, W. C. 76
McLaren, D. K., Ltd. 69
Merchants Rubber Fdy..... 47
Morrison Brass Mfg. Co., Jas. Outside back cover
Morse Chain Co. 75
Murphy Iron Works 3

N

National Boiler Seam Protector Co. 58

PAGE

P

Peacock Brothers 87
Peerless Rubber Co. ..... Inside front cover
Penberthy Injector Co., Ltd... Front cover
Pennsylvania Flexible Metallic Tubing Co. 54
Pratt & Cady Co. 52

S

Sarco Co., Inc. 47
Scaife, Wm. B., & Sons Co... 86
Schaeffer & Budenberg Mfg. Co. 6
Shell-Bar, Boico Supply, Ltd.. 3
Smart-Turner Mach. Co. 77
Starrett, L. S., Co. 61
Steel Mill Packing Co..... 70
Sturtevant Co. of Canada, B. F. 45

T

Toch Bros. 61
Trimont Manufacturing Co.... 78

U

Uehling Instrument Co..... 77

V

Vilter Mfg. Co. 10

W

Wall, W. J. 68
Waterous Engine Works Co... 1
Watson & McDaniel Co. 76
Williams & Co., J. H. 78

Y

York Mfg. Co. 12

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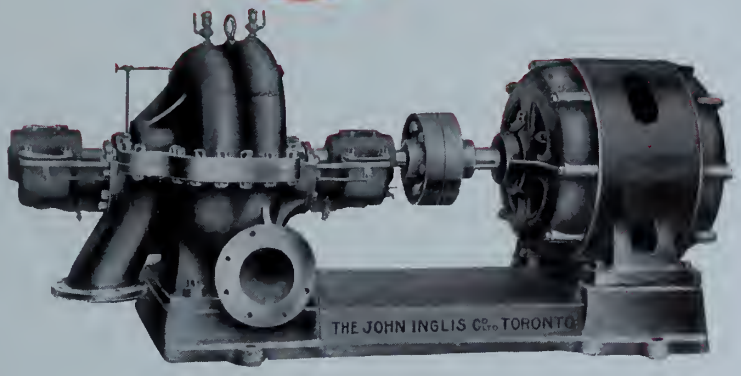

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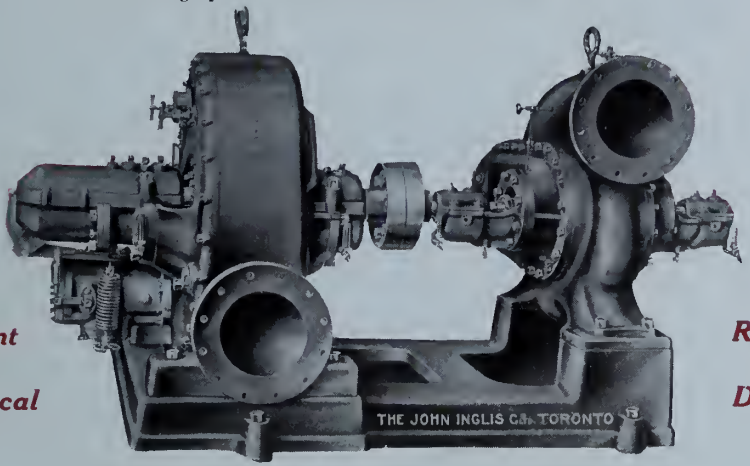

Efficient and Economical

Reliable and Durable

Illustration No. 2 shows Double Suction Pump for circulation low or medium heads. Direct connected to steam turbine.

Leading power plants in Canada regard *Inglis Engines* as the standard by which all engines must be judged.

Oil ring bearings, hydraulic balance and water-cooled thrust bearings are features of their ideal construction. Impellers and passages are highly finished. all working elements being carefully balanced against vibration.

THE JOHN INGLIS COMPANY, LIMITED

ENGINEERS AND BOILERMAKERS

14 Strachan Avenue - - Toronto, Canada

OTTAWA REPRESENTATIVE: J. W. ANDERSON, 7 BANK STREET CHAMBERS

MORRISON'S

Steam Goods and Specialties

J.M.T. Reducing Valve
Will Not Equalize.

Morrison's products have a clean record of success in the power houses of Canada covering a period of nearly two score of years. They represent the highest quality and the most modern designs in their line.

Approved by Dominion and Provincial Government inspection. All goods thoroughly tested before leaving factory.

"BEAVER"
Combined Stop and Check Valve

Stop Valves	Check Valves	Gate Valves
Safety Valves	Relief Valves	Reducing Valves
Inspirators	Injectors	Ejectors
Jet Pumps	Steam Traps	Water Gauges
Boiler Mountings	Gauge Cocks	Pressure Gauges
Vacuum Gauges	Recording Gauges	Ammonia Gauges
Gauge Boards	Oil Cups	Lubricators
Lumber Measuring Machines	Packing Tools and Supplies	
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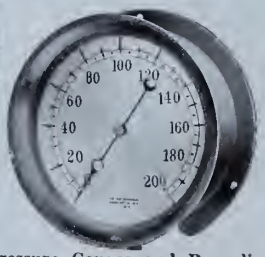
Straightway
Radiator Valve.

J.M.T. Gate
Valve

Gem Ejector

Gate Valve

Model "C"
Safety
Valve



Pressure Gauges and Recording
Instruments

James Morrison Brass. Mfg. Co., Ltd.

93-97 Adelaide Street West - - Toronto, Canada

POWER HOUSE

A monthly newspaper devoted to the Generation, Transmission and Application of Steam, Gas, Electric, Air and Water Power; and to the operation of Refrigerating Machinery.

Published by The MacLean Publishing Company, Limited, 143-153 University Ave., Toronto

MONTREAL: Southam Bldg. LONDON, ENG.: 88 Fleet St., E.C. WINNIPEG: 1207 Union Trust Bldg.

Vol. X—No. 12 Publication Office, Toronto—December, 1917 Published Monthly $1.00 per Year.

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REGRINDING BRASS VALVES

Are especially adapted for

The Shipbuilding Trade

Approved and Registered for 200 lbs. Steam Pressure.

For Marine Engineering

The Penberthy Regrinding Valve is specially suited. Made with the metal-to-metal seat, ground to a tight fit, which forms an ideal seat to resist the high velocity of steam. Heavy union bonnet ring secures bonnet to body, making a non-corrosive and steam tight connection. This bonnet construction appeals very strongly to the high grade Engineer. The finest quality of metal is used in making Penberthy Valves and it is liberally distributed throughout to insure strength and rigidity. Long, graceful sweep of body permits easy flow of liquids or steam, thereby reducing friction to a minimum.

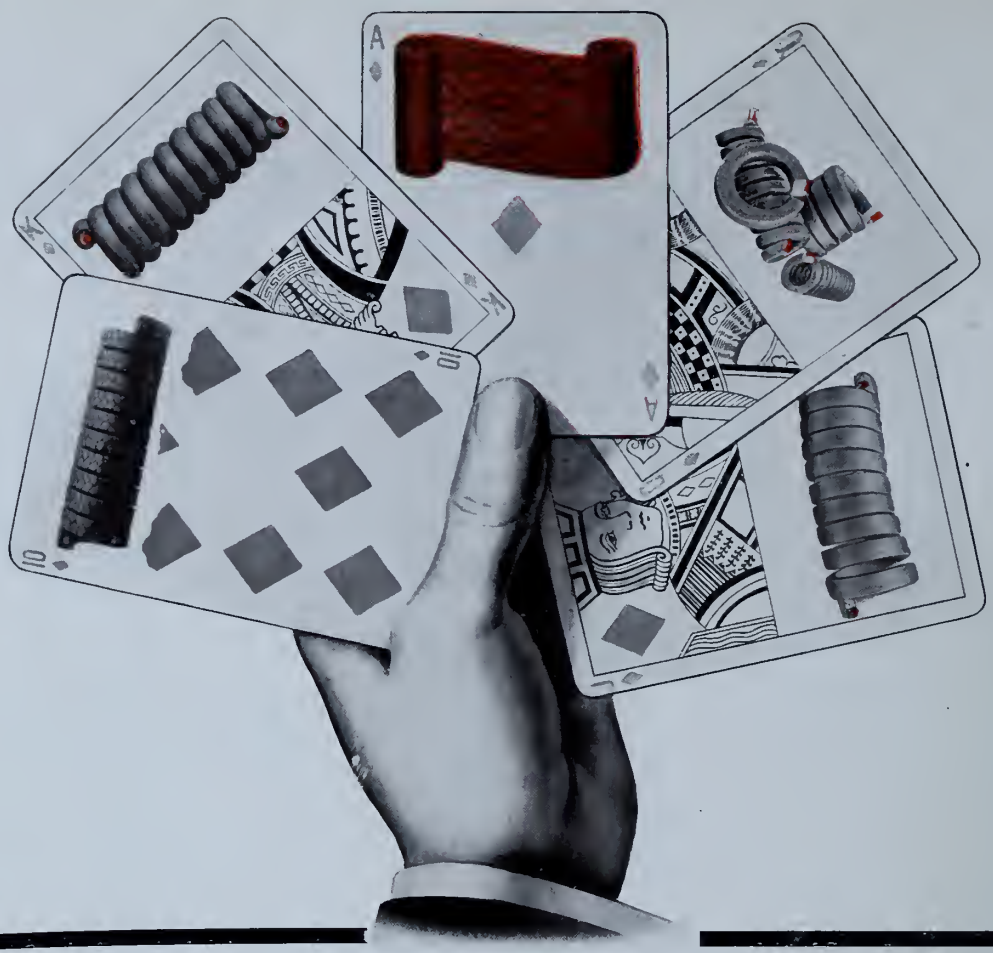
All valves fitted with packing glands and followers.

"PENBERTHY VALVES ARE JUST AS HIGH GRADE AS PENBERTHY INJECTORS."

Write for Free Valve Catalog.

Penberthy Injector Company, Limited, Windsor, Ontario

HIGH-GRADE VALVE MANUFACTURERS



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That Calls the Bluff on Imitations

Every Peerless Packing is built up to a standard, not down to a price. They give service.

In these times when power plants are being forced to their limit it is policy to use the best packing you can buy, it means saving of power and time.

For economy's sake use Peerless Packings.

Peerless Rubber Manufacturing Co.

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CANADIAN ASBESTOS COMPANY

Toronto and Montreal

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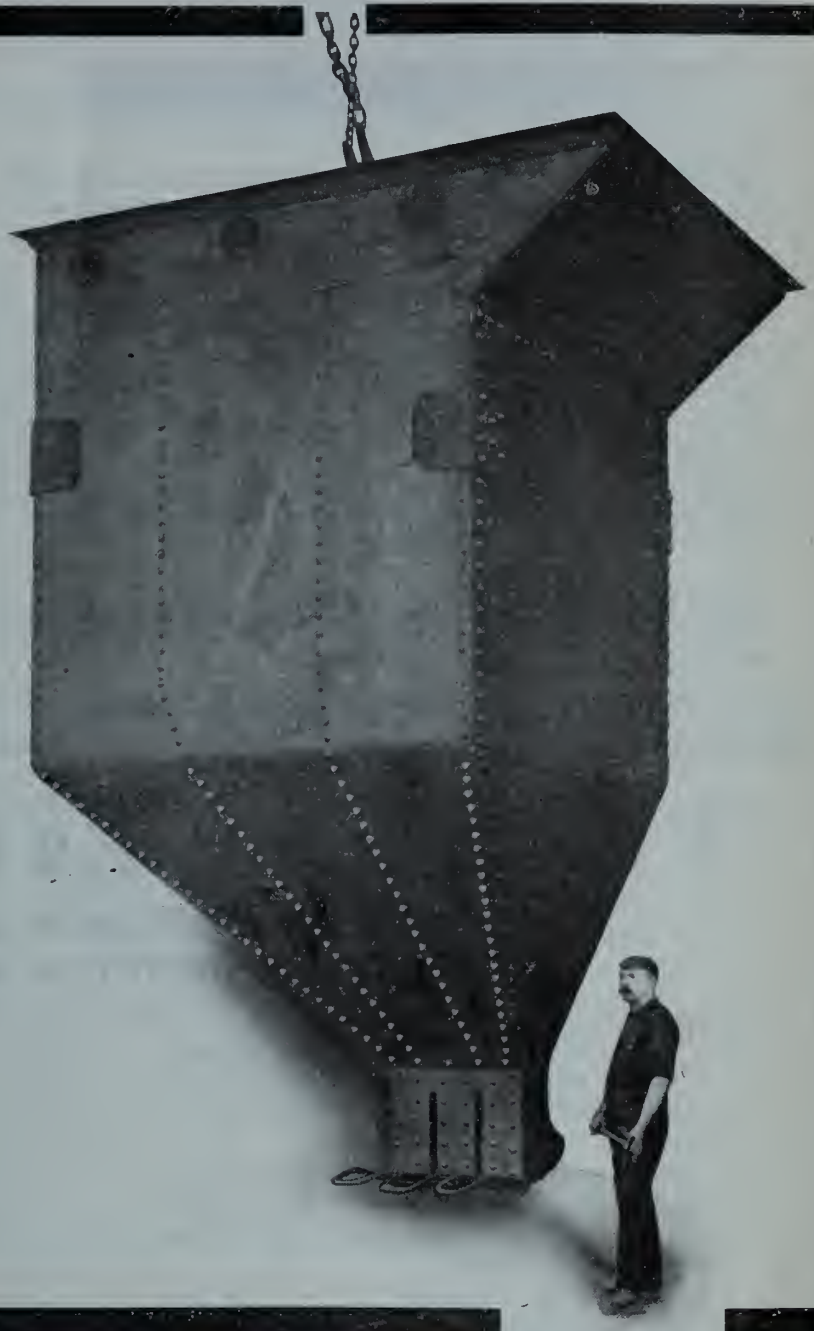
Steel Plate Work

WE have specialized on Steel Plate Work. A separate department in our large boiler shop is devoted entirely to this class of work. Our shops are up-to-date, our equipment is second to none, and we have had 60 years' experience. All are combined to turn out your job as it should be.

We build: TANKS, BINS, STEEL PIPE, ELEVATORS AND CONVEYORS OF ALL KINDS, STEEL STACKS, STEEL BUCKETS, DUMPING SKIPS, SCREENS, Etc.

If you are interested in getting anything along these lines, send your sketch to us, and let us quote. Our prices are reasonable. We guarantee our workmanship.



Waterous

BRANTFORD, ONTARIO, CANADA

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HOYT METALS

FOR well toward half a century Hoyt Babbitt Metals have fought friction by prevention. To-day—excepting enemy countries—they are giving super-service all over the world. Would our annual sales total over $5,000,000 if Frost King and other Hoyt Babbitts were not far and away superior?

Try Frost King—our general purpose Babbitt. We've put 40 years' Babbitt-making experience into compounding it.

Try Nickel Genuine—probably as perfect as an alloy can be made for use in gas and gasoline engines, all classes of marine engines and automobile engines.

Frost King and our specific purpose Babbitts are described in the Hoyt catalog. Also how these super-service Babbitts will lighten the Babbitt expense in your plant is told. Write for a copy.

HOYT METAL CO., Toronto

NEW YORK, N.Y. LONDON, ENG. ST. LOUIS, MO.

Fighting Friction

You Can't Eat a Boiler

and in appearance all boilers are much the same

SO what is a man to do? Provided he realizes that some boiler-building methods are good, that some are bad—and he doesn't know which is which—what is he to do?

Should he read what Boiler Builders have to say about their principles of design, their methods of construction, and their facilities for the work?

Should he see a Jenckes' Boiler under load and have a talk with the plant owner, the engineer and the fireman?

Should he quietly run down to the Jenckes' Works at St. Catharines, Ontario, and see for himself whether all he's been told about Jenckes' uncommon Boiler-Building facilities is correct?

Are these the things he should do? Well, if he takes half the care that these things suggest, he will select the best boiler made; and that is to say, our shipping department will load it.

Write for Jenckes' catalog of Horizontal Tubular, Vertical Tubular, Locomotive Types, and Heating Boilers.

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Montreal
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The Jenckes Machine Co., Limited

St. Catharines, Ont. Sherbrooke, Que.

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JENCKES BOILERS

Get in Touch with Users of BOICO

Users include a large number of the biggest plants in Canada. We will be pleased to send you their names.

Boico does not contain any caustics or metallic substances. It will not injure packings, valves or any metals. It will not carry over in the steam, foam or prime.

It will keep your boiler free from scale and cut the cost of fuel, oil and packing. Write for *free* sample package.

Removes Boiler Scale and Prevents further Formation.

Anti-Clinker Shell Bar Grates

mean much more heat from much less coal. Half of their total surface is air space. It is this abundant air supply that commands perfect combustion—and perfect combustion adds 25% more heat to the fuel gases and prevents clinker formation. Say you want all the facts.

Daniel's P. P. P. and Ebonite Packings for all Pressures. Only packing backed with scientific proof that it reduces friction. Long tests by Mechanical Engineers proved that P. P. P. saved 75% or more friction losses. Automatically regulates bearings on rod to requirements.

Tip-It Patent Welding Process. Scarcity and high price of high-speed steel compels rigid economy in its use. TIP-IT welding makes it possible to obtain tools with carbon shank permanently united to cutting tip of high-speed steel.

Copper Asbestos Boiler Gaskets—most successful boiler gasket made. They never blow out and never stick. Made of corrugated copper, with pure asbestos, cord filled corrugations. Use them and end all leaks in pipe lines.

Shell Bar, Boico Supply, Limited

376 Dufferin Street - - - Toronto, Canada

Murphy AUTOMATIC Furnace

Michigan Alkali Company, Wyandotte, Mich.

1st order was sold by M. C. Huyette, Manager of our Canadian District.

Exhaustive tests were made by Prof. Carpenter of Cornell University.

They know what they are buying!

1st	order	Nov., 1897	2	furnaces,	500 H.P.
2nd	"	Apl., 1898	19	"	4750 H.P.
3rd	"	Apl., 1898	3	"	595 H.P.
4th	"	Sept., 1898	1	"	200 H.P.
5th	"	Nov., 1898 (with Dryers)	8	"	640 H.P.
6th	"	Apl., 1899	6	"	1500 H.P.
7th	"	Jan., 1900	4	"	1000 H.P.
8th	"	Mar., 1902 (with Dryers)	28	"	2240 H.P.
9th	"	Mar., 1902	12	"	3000 H.P.
10th	"	Aug., 1907	4	"	1000 H.P.
11th	"	Aug., 1910	10	"	4000 H.P.
12th	"	May, 1911 (Carbonating)	8	"	640 H.P.
13th	"	Apl., 1914	5	"	2000 H.P.
14th	"	Sept., 1915	5	"	2250 H.P.
15th	"	Oct., 1915	2	"	800 H.P.
16th	"	Oct., 1915	1	"	450 H.P.
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16 Repeat Orders! 20 years' experience with Murphys! 128 Murphy Stokers!

Their Murphy stoker experience must be satisfactory or they would not have bought, recently, two second-hand boilers and the Murphy stokers, which went into service in 1905=130 Murphys in 20 years.

For printed matter, write to-day to

MURPHY IRON WORKS,

BUFFALO, N.Y., or DETROIT, MICH.

If any advertisement interests you, tear it out now and place with letters to be answered.

up! goes COAL

and as coal prices soar, mighty lively grows the demand for

The Jones Underfeed Automatic Stoker

Now supposing we installed a Jones Underfeed Automatic Stoker for *you* under your boilers and it sliced one-quarter off your coal bill;

Wouldn't that offset materially the high coal prices?

The Jones Underfeed Automatic Stoker will do more than greatly reduce consumption of coal in your boiler room.

It will give you more steam from less coal—and cheaper coal.

It will save the cost of coal-shoveling labor.

It will make your smoke stack smokeless.

It will pay for itself over and over, whether your boiler plant is large or small.

Write for our booklet illustrating Canadian installations and read what Canadian manufacturers say about the saving and service of the Jones Underfeed Automatic Stoker.

Jones Underfeed Stoker Co.
LIMITED
37-41 Britain Street, TORONTO

Boiler House Elevators

OUR new catalogue of time and labour-saving elevators is now ready. Copies will be sent post free on request. It is well printed and profusely illustrated with photographs of actual installations. Write for your copy now.

8" Ash Elevator.

We are experts in Boiler House Efficiency. Schemes for handling coal or ashes prepared to any requirements.

Ed. Bennis & Co.
Limited
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28 Victoria Street, S.W.1
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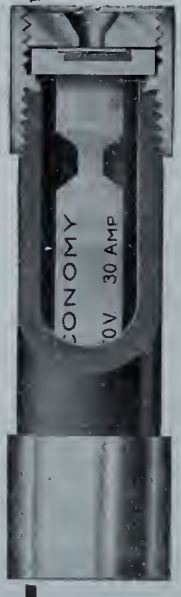
Economy RENEWABLE Fuses



Millions in use are cutting fuse costs 80% for thousands of plant owners.

Any one can renew a blown Economy renewable Fuse in a moment and in another moment have it back in the circuit protecting life and property.

Sanctioned by Canadian Fire Underwriter's Association.

Ask for free samples and Catalog 24.

ECONOMY FUSE & MFG. CO. OF CANADA, LIMITED
UNITY BUILDING - MONTREAL
Manufacturers in Canada of "S. & C." High Potential Fuses--to 150,000 Volts

GALT SPRINKLER STOKERS

are reliable, inexpensive and efficient

BOILER CAPACITY COMBINED
WITH SMOKELESS COMBUSTION

A post card will bring catalogs and full information

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Toronto Representative: W. M. McROBERT, 92 SYMINGTON AVE. Phone: Junction 3354

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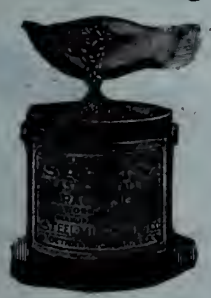


In Bulk

SAFETY PLASTIC

METALLIC PACKING

FOR STEAM, WATER, AIR, GAS, ETC.

Pat. Dec. 22, 1903 Highest Award World's Fair, St. Louis, 1904

GUARANTEED TO LAST THREE YEARS

WITHOUT RENEWAL

Drop us a line and let us tell you all about this Remarkable Packing.

STEEL MILL PACKING CO., WINDSOR, ONT. Established 1899

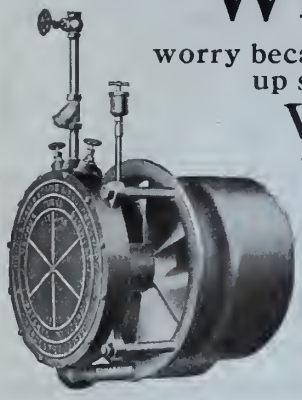
Practically Frictionless

In Cotton Tubes

WHY

worry because you cannot keep up steam pressure

WHEN



it is so easy and cheap to overcome your difficulties by installing a

COPPUS TURBO BLOWER

It means constant steam pressure, regardless of uneven loads, poor draft and poor coal, and it will pay for itself in a short time on account of better combustion. It also will increase your boiler capacity to 200, and even 300%, of its normal rating without injury to the boiler. Cut out this Ad., put your name and address on the margin and mail to us. Without further trouble you will get all the particulars.

500,000 H.P.

In boilers equipped with Coppus Turbo Blowers in four years. The Coppus has replaced a great many other blowers, but no other blower has ever replaced a Coppus.

Coppus Engineering & Equipment Company

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Reducing Valves

Pump Regulator
Balanced Valves
Damper Regulators

If you order a Mason you will get absolute satisfaction. This we guarantee you. You simply cannot make a mistake.

Dependable regulation under every possible condition.

Our complete catalog tells you WHY. Let us mail you a copy.

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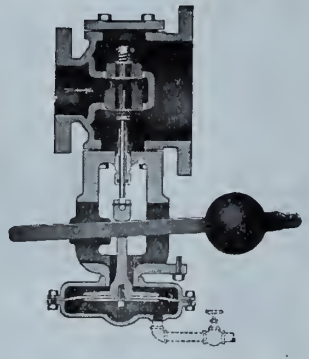

Kieley & Mueller Specialties

Regulating Valves
Back Pressure Valves
Pump Governors
Separators
Traps

FOR EVERY SERVICE

SALES ENGINEERS

THE ARTHUR S. LEITCH CO.

TORONTO

When Buying Thermometers

There's Just Three Things to Remember—

First, you must have accuracy and sensitiveness—

Second, durability is absolutely essential—

Third, the thermometer must be suitably constructed for the intended application.

Accuracy, sensitiveness and durability are absolutely guaranteed in

"Crescent" Thermometers

And with nearly seventy years of experience to our credit, we are qualified to properly interpret your needs.

Our Catalog P.H. 200 illustrates and describes "Crescent" Thermometers for every application. Also test thermometers, glass thermometers, etc.

Get a copy of Catalog P.H.-200 to-day.

The Schaeffer & Budenberg Mfg. Co.

Brooklyn, New York

Chicago
Pittsburg
St. Louis
Philadelphia
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Power Plant thermometers for all temperatures not exceeding 1000° F

Also—"Columbia" Recording Gauges and Thermometers, Gauges, Gauge Testers, Tachometers, Steam Calorimeters, Counters, etc.

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If Quality of Manufacture and Reliability in Service

have any meaning in the Engineering World, this list of our leading specialties should appeal to the best judgment of every Engineer and Power Plant Superintendent.

Mason Standard Bronze Reducing Valve

Mason Reducing Valves (Genuine),
Mason Pump Governors,
Mason Pressure Controllers.

Bundy Steam Traps for every service,
Coppus Turbine-driven Blowers,
Sims Hot Water Generators.

Sims Storage Heaters,
Sims Open Feed Water Heaters.

Bundy Oil Separators,
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Federal Metallic Packing,
Everlasting Blow-off Valves.

Bawden Pumps (Reciprocating & Centrifugal)
Stratton Steam Separators.

Reilly Multicoil Feed Water Heaters,
Reilly Evaporators and Distillers,
Reilly Multiscreen Feed Water Filters.

New Bundy Return Trap

Mason No. 55 Pump Pressure Regulator

ABOVE EVERYTHING

our Sales Engineers know the *practical application* of our lines to *actual conditions*, and sell from *knowledge*, not from *catalogs*. We furnish *results*, not merely *machinery*.

Reilly Multicoil Feed Water Heater

THIS MEANS REAL SERVICE

Bulletins and full information gladly furnished.

The Mason Regulator & Engineering Co., Limited

Successors to H. L. PEILER & COMPANY

MONTREAL, 380 St. James Street — FACTORY, 960 St. Paul Street, Montreal

TORONTO REPRESENTATIVES, The Arthur S. Leitch Co., 506 Kent Building, TORONTO

You Use It So Much—— Better Be Sure It's Good!

STEAM Hose is one of your important details. Year in and year out, it plays its part in the daily task of every engineer.

Because you use it so much, because it is an important part of engine room equipment—be sure it's good!

Steam and rubber are natural foes—as every man who handled hose has learned. Goodyear Steam Hose has been built with this knowledge. The inner rubber tube has been made as steam-resistant as Goodyear specialized skill and science can achieve.

As far as we believe is possible, the tendency for rubber to harden and crack under the action of steam has been overcome in Goodyear Steam Hose.

So, too, with the rubber cover—Goodyear laboratories have striven to produce a steam hose whose outer cover would adhere firmly and never blister or crack.

The plies are of durable fabric. They are welded together with a grade of rubber that remains elastic and active.

In short, in Goodyear you can get a steam hose that resists the action of steam—does not harden—stays flexible—lasts longer.

It offers you in the highest degree the trouble-saving qualities you seek—safety and economy.

Next time you take up with the "boss" a steam hose purchase, specify Goodyear. Tell him of the hose problems that Goodyear has solved for others. Suggest that he get in touch with the nearest Goodyear office and seek its expert advice on hose problems.

GOODYEAR Steam Hose

The Goodyear Tire & Rubber Company of Canada, Limited

Branches—Halifax, St. John, Montreal, Ottawa, Toronto, Hamilton, London, Winnipeg, Regina, Calgary, Edmonton, Vancouver

SERVICE STOCKS IN SMALLER CITIES

JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

JOHNS-MANVILLE

Behind the Power that Turns the Wheels of Your Life

YOUR food, your clothing, your equipment for life's work, come from the collective efforts of thousands of manufacturing plants, which in the struggle to meet your demands, compete in quality, in price and in service.

To do this, these manufacturers must operate their establishments at highest efficiency—must protect their plants against countless costly leaks such as waste heat, friction, wear and tear, and breakdowns.

Many American manufacturers rely on Johns-Manville maintenance materials to check these losses. For example, they improve the efficiency of pumps and engines by packing them with Johns-Manville Sea Rings, the packing that reduces friction to a minimum. The brick arches over the blazing boiler fires are protected from the flame's white heat by Johns-Manville Refractory Cements. Again, the valuable heat transferred through pipes, ducts and flues is conserved by Insulations made from Johns-Manville Asbestos and Magnesia. And in hundreds of other instances, Johns-Manville materials are employed to reach you with a better product at the lowest cost.

So that of all the ways—some direct, some devious—by which Johns-Manville serves the public, none is more important than this function of maintenance, this power economy at the very heart-center of industry.

The Canadian H.W. Johns-Manville Company, Limited

Montreal Toronto Vancouver Winnipeg

JOHNS-MANVILLE POWER PLANT MATERIALS

A variety of specially developed insulations, including: Asbesto-Sponge Felted Insulation, 85% Magnesia Insulation, Asbestocel Insulation.

Packing and other Power Plant specialties, such as:

Underground Insulation System for Pipes
The Johns-Manville Fire Extinguisher
The Johns-Manville Steam Trap
Asbesto-Metallic Brake Blocks
High Temperature Cements
The Johns-Manville Sea Ring
Universal Piston Packing
Mogul Valve Stem Packing
Kearsarge Boiler Gaskets
Service Sheet Packing
Seigelite Sheet Packing
Duplex Packing

A Johns-Manville Sea Ring

If any advertisement interests you, tear it out now and place with letters to be answered.

THIS IS THE SEASON

To Consider

Your Cooling Requirements for Next Summer

You will need a dependable equipment —

Linde Refrigeration and Ice Making Machinery

Presents highly individualized construction.

We manufacture and cater to the small user as well as the larger.

The Linde Canadian Refrigeration Co., Ltd.

MONTREAL: 37 St. Peter Street

Twenty-five Years' Service to Canadian Users.

Vilter Refrigerating and Ice-Making Equipment

is recognized as standard throughout the world. Our product is built in all sizes and capacities, suitable for every service to which refrigeration is applied. Write us for an estimate covering your requirements.

POPPET VALVE and CORLISS ENGINES.
Ammonia Fittings, Condensers, Brine Coolers, etc.

Bulletins sent upon request.

THE VILTER MANUFACTURING CO.

242 Beecher St. Milwaukee, Wis.

ENDURANCE THE SUPREME TEST

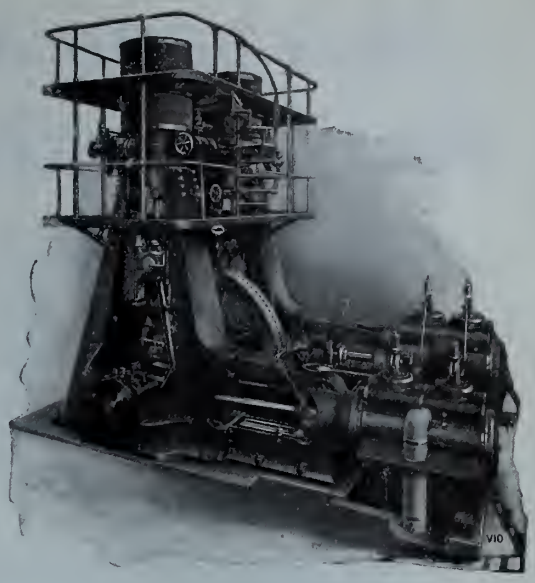
of Ice-making and Refrigerating Machinery.

Continuous operation, overloading to meet increased demand, excessive condenser pressure, etc., are the unforeseen forces often placed on Ice-making and Refrigerating Machinery.

Frick Machinery has been standing up under the above conditions, in many cases, for almost a half century, and doing the work in most cases 365 days of the year, 24 hours per day, because they are built **to go and do go** under the severest conditions.

May we assist you in planning your new installation or making alterations to your present plant?

Write for our latest catalogues and bulletins.



Frick Company
WAYNESBORO, PA. U.S.A.
ICE MACHINERY SUPERIOR SINCE 1862

Canadian Representatives:
FRICK ICE & REFRIGERATING COMPANY, Montreal, Canada

2,400,000 Board Feet of Nonpareil Corkboard Insulation Used in this New Building

This new building of the Chicago Cold Storage Warehouse Company, Chicago, Ill., is one of the most modern cold storage plants in the country. The interior structure of concrete and steel carries the load of the building and its contents, making it possible to enclose the entire building with a continuous envelope of Nonpareil Corkboard Insulation, and thus secure maximum protection against in-leakage of heat.

It is a significant fact that Nonpareil Corkboard is being used in most of the up-to-date plants, large and small. Its low heat conductivity, resistance to moisture, ease of erection and remarkable durability, make it the cheapest insulation in the long run that can be purchased.

The supporting structure of the building before the Nonpareil Corkboard was installed

Why not write for literature and sample?

Armstrong Cork & Insulation Company, 504 McGill Bldg., Montreal, Que.

Also makers of Nonpareil Cork Covering for cold pipes; Nonpareil High Pressure Covering for steam lines; Nonpareil Insulating Brick for boiler settings; Circle A Cork Brick for cold storage room floors; and Linotile for floors in offices, residences, etc.

Mechanical Refrigeration

is essential to success in many lines of manufacture, and YORK Products have played an important part in the development and expansion of these lines over the entire field.

We not only design and make a Refrigerating Plant suited to the needs of our customers, but all the details are handled by our own organization, which assures the best service possible.

YORK Refrigerating Machinery is the result of years of careful research, exhaustive tests, and the labor of experienced Engineers and competent Workmen; and for the Manufacturer who depends on the quality of his product for the continued success of his business, it is the logical equipment to buy.

Write us for information and prices.

YORK MANUFACTURING CO. - YORK, PA.

(Ice-Making and Refrigerating Machinery Exclusively)

Represented in the Dominion by

CANADIAN ICE MACHINE COMPANY

MONTREAL, 626 Coristine Building. TORONTO, 82 Chestnut Street. WINNIPEG, 85 Lombard Street

1905

Illustrative of our *progress* in EIGHT years and truly applicable proportionately to the last FOUR years.

"WHY?"

***We aim constantly to excel* in every phase of COLD STORAGE DOOR PRODUCTION.**

Satisfied users assure us of *Repeat orders* and our conscientious efforts to so serve you as to insure higher efficiency and economy—*success*—makes our progress *positive.*

1913

Careful investigation into the *relative merit* of the various makes of *COLD STORAGE DOORS* means an order for *JAMISON*—or else your LOSS.

JAMISON COLD STORAGE DOOR CO., Inc.

Formerly JONES COLD STORE DOOR CO.

HAGERSTOWN, MD. - U.S.A.

P.O. BOX 93

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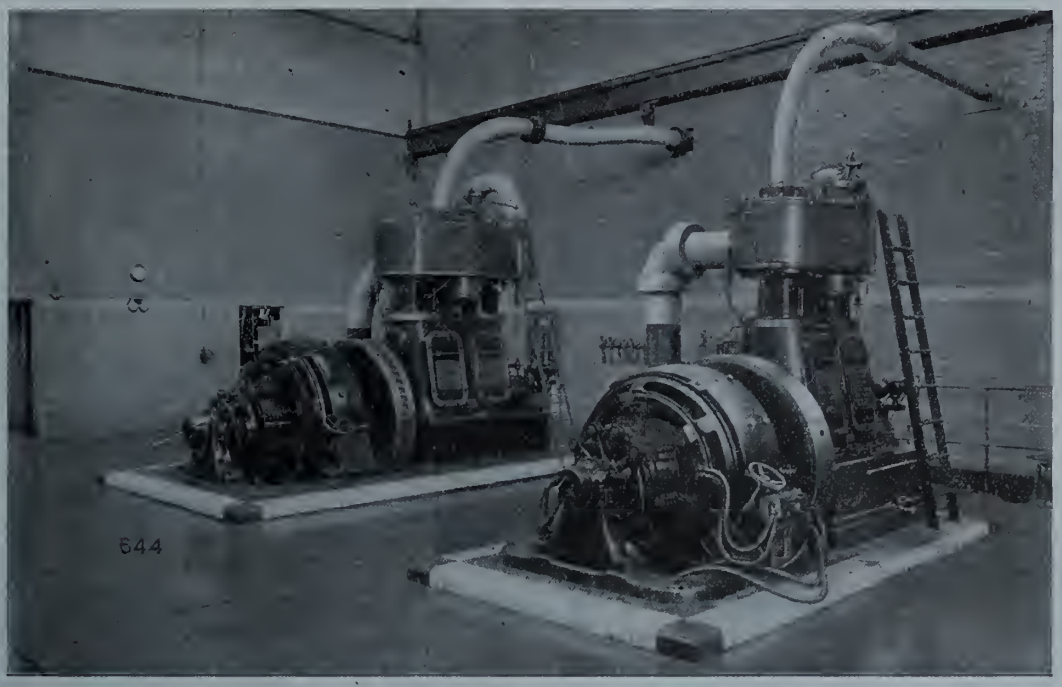

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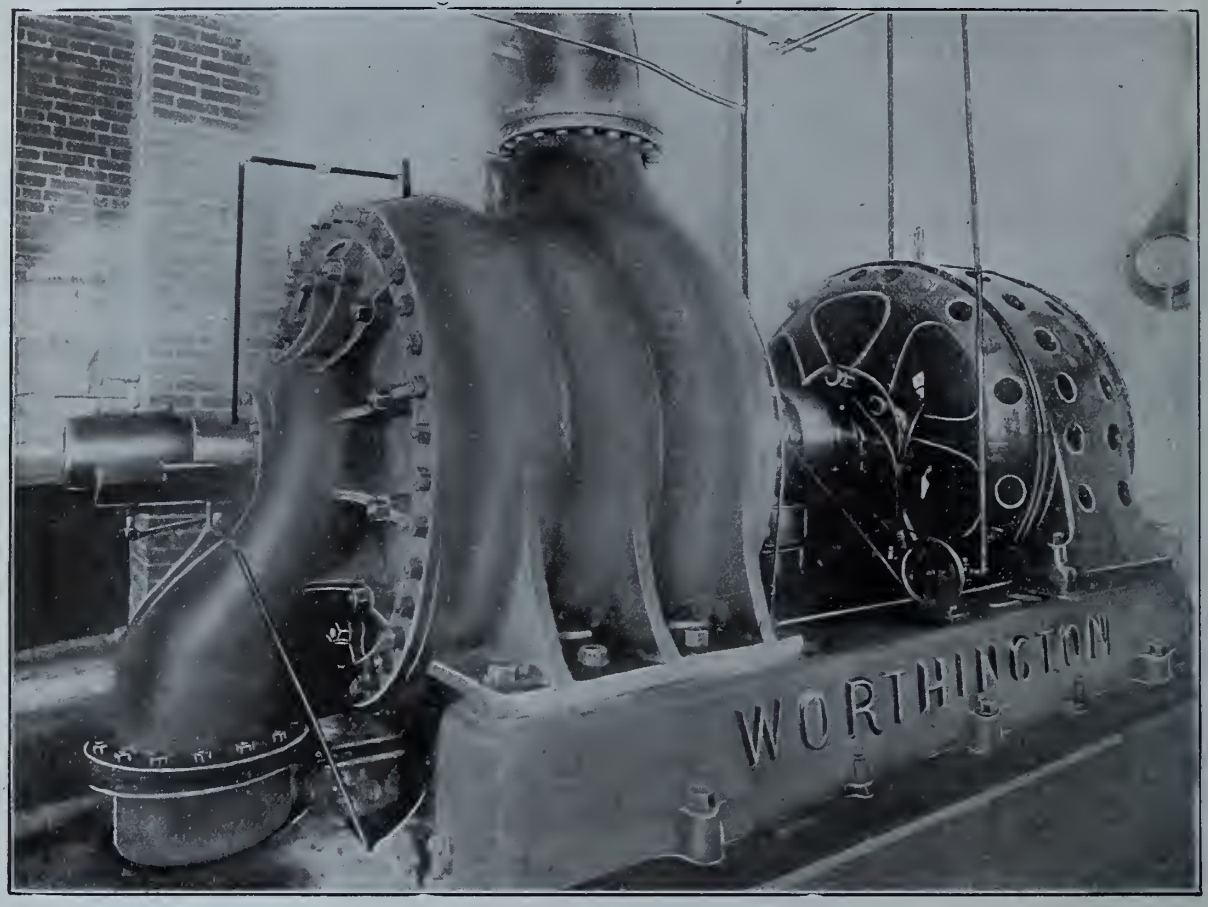

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The Canadian General Electric Co., Limited, was organized in September, 1892—just a quarter of a century ago.

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The Canadian General Electric Co., Limited, manufactures Electrical Apparatus and Supplies for Railway, Light and Power purposes.

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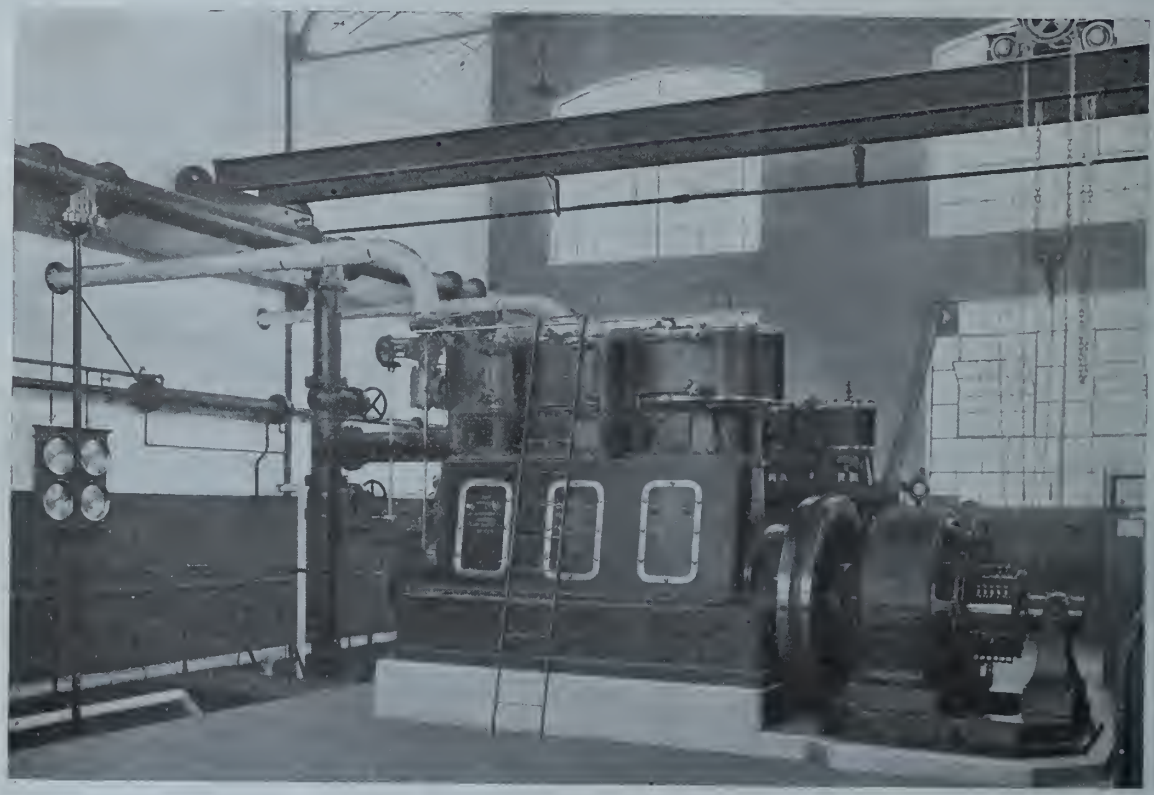

A corner in the Engine Room of our New Power Plant recently erected at our Main South Works. Equipped with G. & McC. Co. Three-Cylinder Compound and Two-Cylinder Compound Vertical Forced Lubrication Steam Engines.

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WE BUILD

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The advice of our Engineering Experts, our Catalogues, Specifications, Photographs, etc., will be cheerfully supplied to interested parties.

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Plant, Equipment, and Product, The Goodyear Tire & Rubber Co of Canada.

The rise of rubber in industrial importance from a laboratory curiosity to one of the most indispensable substances of civilization, in peace or war, forms one of the romances of the nineteeth century. The extent to which rubber enters into the needs of mankind's daily existence are numerous beyond belief, and the immensity of the plant described in this article, devoted as it is to one special product, will serve to emphasize the importance of rubber.

THE factory which the Goodyear Tire & Rubber Co. of Canada, Ltd., have recently built at New Toronto, Ont., is symbolical of the remarkable success which has attended the automobile tire manufacturing business in the Dominion, and, judging from the plans which this concern has made for future enlargement, there is every expectation of even greater expansion in this industry. The Goodyear Co., as is perhaps well known, supplied until now the Canadian trade from their factory at Bowmanville, Ont. The need for greatly increased manufacturing facilities to meet the demand for their product ultimately became urgent, and New Toronto was selected as the best location for the new tire plant. The Bowmanville factory, however, is still in operation, and is devoted exclusively to the production of mechanical rubber goods. The removal of the tire plant to the new factory will permit of a greatly increased output of mechanical rubber goods at Bowmanville, while the production of tires at the New Toronto factory will, of course, be considerably greater than at the old plant.

Experience Plus System

Advantage has been taken of many years' experience in the tire business to plan the layout of machinery and equipment at the new factory, and in this respect it may be said that nothing has been omitted whereby the rapid and efficient production of tires is made possible. The various processes, from the mixing of the raw materials to the finished product, follow one another in regular sequence, with no waste effort or back trucking. Each operation or process has also been carefully planned to produce a perfect tire without any undue expenditure of either time or energy. The resultant efficiency enables producing costs to be kept within prescribed limits.

An elaborate cost system is employed, which enables the staff to keep track of all charges and eliminate unnecessary expenditure of time or material. An experimental department is maintained to try out new ideas either in the mixing of raw materials or in manufacturing processes. In connection with this department is a chemical and physical testing laboratory. The statistical department collects and prepares all kinds of data relative to the operations in the factory, while there is also an efficiency department. Needless to say, all the departments work together with the common aim of maintaining a high standard of over-all efficiency.

Social Features

A suggestion system is in force, many valuable ideas having been submitted by its means and adopted. Boxes with paper and pencil are located at various points to receive suggestions, and any practicable ideas are rewarded in a substantial manner, according to their value to the firm. This system has the advantage of making the employees interested in their work, as well as being beneficial to the company. A welfare department has been organized to adjust complaints and generally look after the health and comfort of the employees. In this connection an athletic field will be laid out and sports of all kinds instituted. This feature will not be inaugurated until the spring, when the weather will permit of laying out the grounds. On the top floor is a cafeteria, where four meals a day are served at cost price. This is a great convenience on account of the entire absence of restaurants in New Toronto.

The company have a property covering about 26 acres, with a frontage facing south on the Toronto-Hamilton Highway. The factory stands some way back from the road, thus leaving sufficient space for future extensions. A spur from the Grand Trunk Railway System enters the property at the back or north side, where the power house is located. The factory comprises one large main building, a power house, cement department and spreading room. The last three mentioned are separate buildings, and are at the back of the main structure. It is the intention of the company to lay out the grounds surrounding the factory in an attractive manner when the weather becomes more favorable for turfing and planting trees. The surroundings will be made as congenial as possible for the employees. The space in front of the main factory building is sufficiently large to allow of two more units being constructed, provision having been made for extensions when the present factory was planned. The same idea was kept in view when the power house was designed, extensions being possible without interfering in any way with the present layout.

Building Details

The main building is 460 feet long by 100 feet wide, and is laid out in 20 feet bays each way. The building comprises four storeys and basement, and is approximately 70 feet high from the ground level. The basement is 12 feet high, and the first floor 22 feet high. The second and third floors are both 15 feet high, while the top floor is 12 feet high to the lower chord of the roof truss, plus 5 feet for the latter. The general construction material of the building is steel and brick, all internal columns through-

out being encased in concrete. In the construction of the main building 2,200 tons of steel were used and approximately 2,225,000 brick. The brick work is of high quality in spite of the fact that the greater part of it was laid during the winter, the successful carrying on of the work being made possible by a liberal use of salamanders. The ground was broken in July, 1916, the erection of the steel work started in November, and the first brick laid on January 3, 1917. Manufacturing operations were commenced in September of this year.

Fenestra steel sash is used exclusively. There are approximately 45,000 sq. feet of sash in the main building, the sections being about 17 feet wide, and ranging from 8 ft. to 15 ft. high. Each sash is equipped with from one to four ventilators. The monitor in the roof, which extends the full length of the building, is made up of three rows of glass on each slope, two of these rows on each side being equipped with opening mechanisms operated by hand from the floor. With so much space devoted to windows, the factory is exceptionally bright and well ventilated. This feature strikes the visitor immediately upon entering, and is a valuable one in that it means healthy conditions for the employees, and consequently more efficient work.

The basement extends under the entire building except for 100 feet at the west end. The basement floor is made up of 8-inch concrete, on which is laid two ply of waterproofing material. On this again is laid 1½ inches of mastic ashphalt. Under the floor is a complete system of tile drainage leading to sewers which are laid in the centre of the building throughout its entire length. There are three lines of sewers for drainage, rainwater, and water from the factory respectively. Downspouts from the roof are placed 40 feet apart inside the building, and are carried to one of the above-mentioned sewers. The first floor is made up of 2 by 4's, laminated on steel and finished with maple flooring for a length of 320 feet.

Another section of the floor, comprising 60 feet, is concrete on steel, with mastic finish laid on waterproofing. The remaining 80 feet is composed of wood blocks laid on concrete. The second floor is made up of 2 by 4's, laminated on steel, with maple finish, except for 80 feet, which consists of wood blocks on concrete. The third floor is composed of laminated 2 by 4's laid on the steel, with maple finish, except for a length of 80 feet at the west end, which is of concrete with cement finish and hardened. The fourth floor is of the same construction as the third. The roof is constructed of 1⅞ by 6 in. boards laid on steel purlins and covered with 4-ply felt. The pitch was poured and not mopped, while the felt is covered with slag instead of gravel.

FIG. 1. COMPOUNDING DEPARTMENT WHERE RUBBER AND THE VARIOUS INGREDIENTS ARE WEIGHED AND PLACED IN BOXES.

Elevators and Lavatories

The building is at present equipped with three elevators, but provision has been made for two more. The capacity of each elevator is 6,000 pounds, and the platform is 7 by 11 feet. All the elevators run from the basement to the top floor and are electrically driven. Each elevator at each floor is equipped with a rising gate, and the openings are protected with steel rolling shutter doors. The elevator and stair wells are of brick and steel construction. All floors and landings are of concrete on steel and have a mastic ashphalt finish. The stairway construction is steel trough, with concrete filling and mastic treads. One notable feature in the construction is the absence of foundations for supporting the heavy mill lines and other heavy machinery on the first floor. The machines are supported on steel beams carried on the main columns of the building. This method of construction gives a clear and unobstructed basement.

Considerable attention has been given to the welfare of the employees in the matter of lavatory accommodation. Lavatories and toilets are provided on each floor, being located on the stairway landings and in separate rooms. The lavatories are provided with hot and cold water, while liquid soap is piped to each bowl from a small overhead tank. Paper towels are provided in preference to the old-fashioned and unsanitary roller towel.

A well-equipped machine shop occupies a part of the main floor at the west end. The equipment installed includes a general line of machine tools suitable for effecting repairs and making parts for the machinery in the factory, the company being independent of outside help in this respect except for castings or heavy work.

Transmission Equipment

The transmission equipment in the factory was supplied and installed by the Dodge Mfg. Co., Toronto, while the ball bearings on the line shafting are of the Chapman type, there being over one hundred sets of ball bearings of one size, in addition to others of varying sizes.

Fire Protection System

A sprinkler system is installed throughout the plant connected to the overhead tank and fire pump. Branches from the system are taken off from four separate risers at different points in the building, each riser having a control valve. There are 6 sprinkler heads to every 20 feet square bay on all floors. The entire system including valves is painted red, all other piping being black. The sprinkler system was installed by

FIG. 2. SECTION OF MAIN FLOOR SHOWING WARM UP MILLS AND CALENDERS. NOTE CONSTRUCTION OF FLOOR AND LOFTY INTERIOR.

the H. G. Vogel Co., Buffalo, N.Y. The tank for the sprinkler system has a capacity of 75,000 gallons and was constructed by the Chicago Bridge & Iron Co., Bridgeburg, Ont.

The power house is one of the outstanding features of the Goodyear factory, embracing as it does some unusually fine equipment. The building is of large proportions and substantial construction while the architectural features are also noteworthy. In the layout, provision has been made for installing additional units and also for making extension to the building when necessary without interfering with the plant as installed at the present time.

Constructional Features

The building is of steel and brick construction and is divided into four sections, namely, the boiler room, pump room, motor generator room, and transformer room. These rooms have the following dimensions:—Boiler room 58 feet by 88 feet; pump room 40 feet by 66 feet; motor-generator room 36 feet by 66 feet, and transformer room 22 feet by 66 feet. This gives the building a total length of 156 feet and a width of 88 feet at the boiler room end and a width of 66 feet for the remainder of the length. The boiler room is 40 feet high, as are also the others.

The windows are of steel sash, are arched in semi-circular form which improves greatly the general appearance of the building. The roof is composed of 2-inch concrete reinforced with ferro-inclave, laid on steel purlins, the ferro-inclave being plastered on the underside. On top of the concrete are laid 2 inch boards which in turn are covered with 4 ply felt roofing, the pitch for same being poured not mopped. This again is covered with slag. The building is fireproof, while the wood over the concrete prevents the roof from sweating.

The basement under the boiler room is 16 feet deep. Two of the basement walls while acting as retaining walls are constructed of brick to allow for future extensions in both these directions. The boiler foundations are of concrete, 16 feet deep. They are constructed so as to take care of expansion and contraction, expansion joints being provided as in the case of the boiler setting. The stack is built in one bay of boiler room, the gases being led to it through a smoke duct in boiler foundations. The stack is 250 feet high and 15 feet internal diameter at the top. Its foundation is of reinforced concrete 36 feet square and designed for a maximum load of 3 tons per sq. foot.

The stack is constructed of radial perforated brick laid with strong cement lime and forming a very strong bond. The perforations form a dead air space around the chimney, insulating the hot column of rising gases on the inside from sudden changes of temperature of the outer air, resulting in a maximum draft under practically all conditions. The stack is large enough to take care of a duplicate boiler installation or a total of six boilers. The stack was constructed by the Custodis Canadian Chimney Co., Toronto.

Equipment Contractors

The power house and its equipment layout were designed by F. H. Breor, chief engineer for the Goodyear Co. Robert L. Finlay is engineer in charge. The entire installation of pumps with one exception were supplied by Epping-Carpenter Pump Co., Pittsburg, Pa. The high pressure piping and fittings were supplied by the Walworth Co., Boston, Mass.; pipe covering by the Canadian H. W. Johns-Manville Co., Toronto; pressure reducing valves by Kiely & Mueller Co. through Arthur S. Leitch Co., Toronto; and steam traps by V. D. Anderson Co., Cleveland, O. The valves are principally by the Lunkenheimer Co., Cincinnati, Ohio. The Crane Co., of Chicago, also supplied some valves. The auxiliary steam turbine and generator set was supplied by the Canadian General Electric Co.

The entire electrical equipment in the power house was supplied and installed by the Canadian Westinghouse Co., Hamilton, Ont. The International Engineering Works, Amherst, N.S., built and installed the boilers. The stokers were supplied by the American Engineering Co., Pittsburgh, Pa.; the fan by the American Blower Co., Detroit, Mich.; and the ash conveyor by the American Steam Conveyor Co., Chicago. All the piping was installed by Bennett & Wright, Toronto. The travelling crane was made by the Northern Crane Wks., Walkerville, Ont. The building was erected by the Dominion Construction Co., and the rolling doors in each of the rooms were supplied by the A. B. Ormsby Co., Toronto. The "Venturi" meter was supplied by the Allen General Supplies Ltd., Toronto.

Boiler Installation

The boiler installation comprises two 600 h.p. Edgemoor type water tube boilers built and installed by the International Engineering Works, Amherst, N. S. Provision has been made for another unit of same capacity when required. They are among the largest boilers ever built in Canada. A feature of this type of boiler consists in the three longitudinal drums which run into the box header. Another point of interest is the distance between the tubes and grate. The first row of tubes is 12 feet from the grate allowing more than the usual amount of space for combustion so that the gases will be thoroughly burned before coming in contact with any part of the boiler having a lower temperature which would create condensation and thus cause smoke. The boilers have flanged headers and seamless steel tubes,

FIG. 3. SECOND FLOOR. FIRE CONSTRUCTION DEPARTMENT WITH STOCK TABLES ON THE LEFT AND BUILDING MACHINES ON THE RIGHT.

FIG. 4. WEST END OF SECOND FLOOR WHERE TIRES ARE CURED AND VULCANIZED.

the latter being 4 inch diameter and 20 feet long. The boilers are designed for a working pressure of 200 lbs. per square inch, but are only operated at 175 lbs. They are equipped with Lunkenheimer non-return stop valves, there being a runway with chainblock overhead to handle the valves. Access is gained to the top of the boilers by means of a steel stairway. Reference to the piping is made under another heading. The boiler fronts are equipped with rolling steel doors supplied by the A. B. Ormsby Co.

Mechanical Stoker Installation

The boilers are equipped with Taylor power dump stokers supplied by the American Engineering Co., Philadelphia, Pa. This is a seven retort machine with a continuous overload capacity of 200 per cent. boiler rating and a maximum peak load capacity of 250 per cent. for four hours; the maximum operating economy is obtained at approximately 150 per cent. boiler rating. The Taylor is a gravity underfeed stoker with inclined fuel bed, and has a hinged dump plate operated by a steam cylinder located underneath. The coal from the hopper is fed into the magazine or retort from which two cylindrical rams driven by connecting rods from a crank shaft, and assisted by gravity, push it into the furnace at an angle to the fire surface. The upper ram shoves the coal outward and upward, distributing it in the coking zone. The lower ram working with the upper acts similarly, but instead of forcing in fresh coal, it impels the fuel bed and the refuse toward the dump plates in the rear.

The necessary air to support combustion is furnished by a power-driven fan located in the boiler room basement. The fan which is direct connected to two vertical steam engines, was supplied by the American Blower Co., Detroit, Mich. The air is driven through ducts to the wind box, thence into the tuvere boxes, and in turn through the fuel bed. The driving unit for the fan drives both the fan and speed shaft, which, in turn, drives a crank shaft which actuates the rams. The crank shafts are in sections; there being a section for each pair of rams, while each group of sections is driven from its own gear box. Since the same driving unit operates both stoker and fan, a change of speed simultaneously changes both rate of feeding coal and rate of supplying air.

Ash Ejector

A Griffin ash conveyor is installed along the front of the ash pit, which conveys the ashes to a pit outside the building. The conveyor which is operated by steam jet was supplied by the American Steam Conveyor Co., Chicago, Ill.

Pump Room

In the pump room are installed all the pumps required for the various services, also the feed water heater, and air compressor. The layout is as follows:—On the west side are two hot well pumps and feed water heater, a boiler feed pump, two high pressure hydraulic pumps, balancing tank and the accumulator. On the opposite or east side are the fire pump, booster pump, two low pressure hydraulic pumps, air compressor and vacuum pumps. All the valves in the piping system connecting the pumps are located in the basement, and are controlled from floor stands in the pump room. The ten ton overhead Northern travelling crane installed here is operated by hand from the pump room floor. All the piping, both steam and water, is carried under the ceiling of the basement under the pump room. The basement is 12 feet high allowing ample head room. At one end of the basement is a sump for waste water and drainage. The sump is equipped with a bilge pump for delivering its contents into the sewer. The pump is a 3-inch Yeoman Bros. submerged centrifugal, driven by a Canadian Westinghouse motor.

All clean returns from the factory services, traps, etc., discharge normally into the hot wells. Make-up water is supplied to the hot wells to make up for losses. Water is pumped from the hot wells by two 7½ x 8½ x 6 in. pumps located near the feed water heater in the pump room. The hot wells are cross connected so that either can be used independently of the other. A 5 x 8½ x 6 in. Epping-Carpenter duplex pump is installed in the basement for delivering clean returns from a sump to hot wells, in case difficulty is experienced at any time in raising returns direct to hot wells. There is a tank on the main floor for settling sand and sediment in the raw water from the lake that goes to the presses. This tank is at a sufficient elevation to put a head on the pump sections. The tunnel through which all the piping is carried to the factory runs from this basement to the factory building basement.

FIG. 5. TWO 600-HORSEPOWER ROBB WATER TUBE BOILERS WITH TAYLOR STOKERS.

Returning to the pump room there are two 7½ x 8½ x 6 inch Epping-Carpenter duplex horizontal pumps for drawing from the hot wells and discharging to the feed water heater. The 4,000 h.p. feed water heater was built by Warren, Webster & Co. Camden, N.J. Next in the line is a 3 inch, 4-stage Epping-Carpenter centrifugal boiler feed pump which supplies water to the boiler from the heater at 225 lbs. pressure. This pump is direct connected to a 35 h.p. Can. Gen. Electric a. c., 2200 volts, induction motor. In the line between this pump and the boilers is a 3 x 1 inch, type M register-indicator-recorder. "Venturi" meter supplied by the Builders Iron Foundry, Providence, R.I., through the Allen General Supplies, Ltd. On the same side of the pump room are installed two Epping-Carpenter 10 x 2 x 2 inch duplex, horizontal, outside packed, pot valve, steam driven pumps. These supply water at 1,500 lbs. pressure to the hydraulic presses in the factory, and operate in conjunction with an accumulator having an 8 inch ram of 8 feet stroke. The valves and fittings on these pumps are Crane Co. make. The balancing tank for the low pressure hydraulic pumps is situated on this side. It is 42 inches in diameter by 12 feet high.

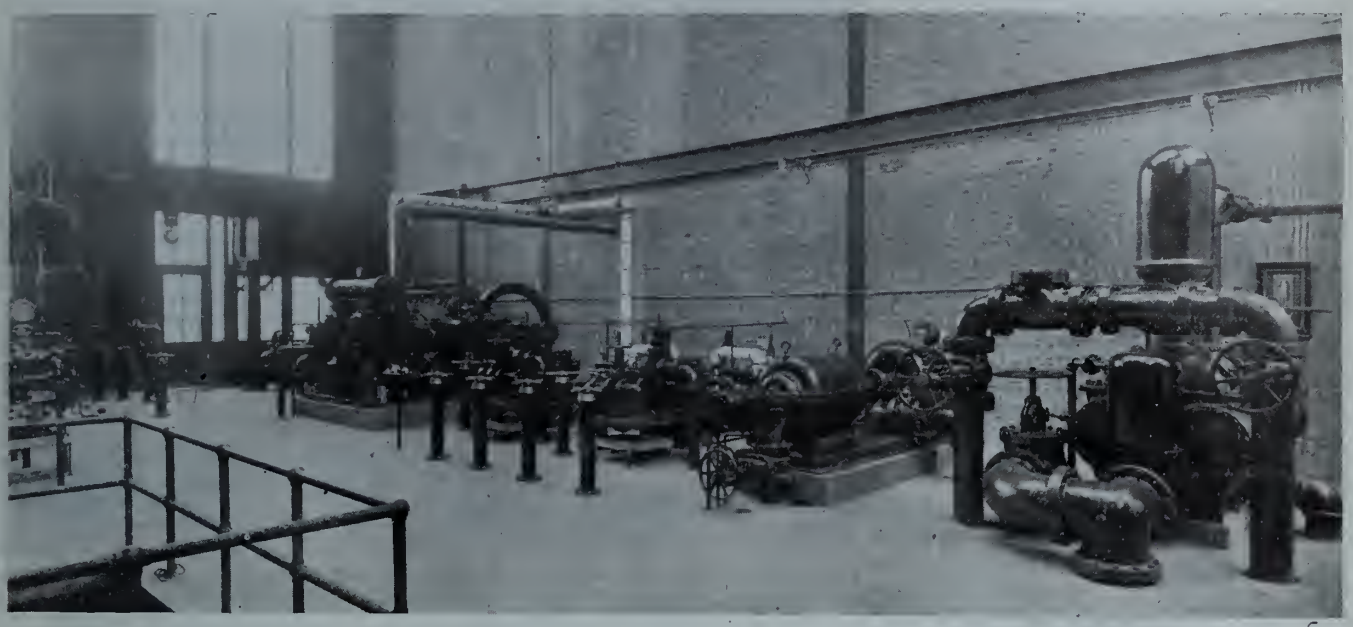


FIG. 6. EAST SIDE OF PUMP ROOM SHOWING, FROM RIGHT TO LEFT, FIRE PUMP, BOOSTER PUMP, LOW PRESSURE HYDRAULIC PUMPS, AND AIR COMPRESSOR.

Fire Pump and Air Compressor

On the east side of the pump room there is installed at the south end a Blake-Knowles 18 x 10 x 12 inch, horizontal, duplex, Underwriters' fire pump, having a capacity of 1,000 gallons per minute. This pump supplies the sprinkler tank and fire system lines for the factory. The next unit is a booster pump for factory water supply, or alternatively for the fire system. This pump delivers water at 125 lbs. pressure to the factory. It is a 6 inch, 3-stage Epping-Carpenter turbine unit direct-connected to a 150 h.p. Curtis steam turbine running at 1,500 r.p.m. Next in line are the pumps for supplying water at 225 lbs. pressure for the presses in the factory. There are two units for this service, both Epping-Carpenter make, of 12 x 6 x 12 inch, duplex, horizontal pot valve type. These pumps operate in conjunction with the balancing tank, but can also be used for boiler feeding in an emergency.

A Laidlaw-Dunn-Gordon air compressor is located on the same side of the plant. This unit is a 10 x 16 x 16 x 10 x 12 inch, cross compound steam driven, 2-stage machine, and delivers compressed air at 100 lbs. pressure throughout the entire plant. It also operates in connection with the balancing tank and a receiver, the pressure being controlled by a Fisher pressure regulator. The vacuum pumps for the heating system are installed at the north end and east side of the pump room. There are two of these pumps, both being Epping-Carpenter 6 x 10 x 12 inch units. They are controlled by a Mason regulator. The gauge board installed alongside the Venturi meter will have 14 Bristol gauges and recorders for steam, hydraulic and water service pressures, vacuum, etc. In the illustration showing the west side of the pump room, two steam lines will be seen. The one on the left hand is the 10-inch steam line for the factory, and the one on the right hand is the 8 inch line feeding the distributing header for the pumps.

Piping System

The piping system is one of the features of the power plant and a great deal of time and ingenuity has been expended on the layout. In designing the system, the principal objective of the engineers was to have the piping for the various services so installed that a tie-up in the factory would be practically impossible. To provide for all contingencies, the various pumps are connected up with the water mains in such a manner that if one pump fails another can be by-passed into the line; in other words, flexibility is the feature of the piping system. The water is pumped to the power-house from the lake by two 8 inch, 3 stage Bawden turbine pumps located in the municipal pumping station there. The water is delivered to the factory through a 12 inch main direct to the factory distributing system. This water, however, can be by-passed to a 200,000 gallon storage reservoir so that, in the event of the pumps at the lake failing, the factory can be supplied from the storage reservoir by means of a 6 inch, 3-stage turbine pump which delivers the water direct into the factory distributing system. One instance of the flexibility of the piping arrangement is the fire protection system. A Blake-Knowles Underwriters' pump can deliver water from the reservoir direct to the factory supply line or from the regular 12 in. supply line. In the event of the fire pump being out of commission, a turbine pump can be by-passed into the line, thus providing four alternative methods of suppling the factory fire system apart altogether from the overhead sprinkler tank.

Alternative methods of boiler feeding are also provided, either direct from the feed water heater, which is the regular way, or from either of two hot wells for which another pump is used, or from either or both the low pressure and high pressure hydraulic pumps. The piping system although complicated has proved thoroughly satisfactory in practice. A detailed description of the system would take up considerable space and would doubtless be confusing to the reader so a more general description only will perhaps better serve the purpose of this article. Taking the piping system as a whole, great credit is due Mr. Breor, the Goodyear Co. engineer who designed the

layout, and to Bennet & Wright, of Toronto, who carried out the work.

Steam Piping System

Taking the steam piping first, steam is received from the boilers by two 8 inch lines to the header. The header is 14 in. in diameter, of wrought steel, with wrought steel nozzles or branches welded to it by the oxy-acetylene process. The flanges are of cast iron and the header is 20 feet long. There is a 10 inch line to the factory, an 8 inch line from the header to the pumps and air compressor on the East side of pump room, and two 4 inch lines, one for the pumps on the West side of the pump room and the other line to the boiler room basement for the ash conveyor, fan engine, etc. The piping is designed for 175 lbs. per sq. inch working steam pressure with 100 degrees Fah. superheat.

The 10-in. line extra heavy steel pipe is carried under the pump room into the basement where the pressure is reduced from 175 lbs. to 100 lbs. by a Kiely & Mueller reducing valve. At this point the line leading to the factory is by-passed, and is equipped with an expansion joint, a steam separator, two Lunkenheimer valves, and an Anderson steam trap. From here the main steam line leading to the factory is carried through the tunnel to a point in the factory basement where the steam is distributed for the heating system and for factory purposes, such as heating, vulcanizing, etc.

A relief is installed at each regulating valve to prevent the pressure building up. The distributing line for the heating system is 6 inches on the high pressure or inlet side, and 12 inches on the low pressure or outlet side of the reducing valves. The pressure from the main line for the heating system is reduced from 100 to 30 lbs., and from 30 to 2 lbs. by Kiely & Mueller reducing values.

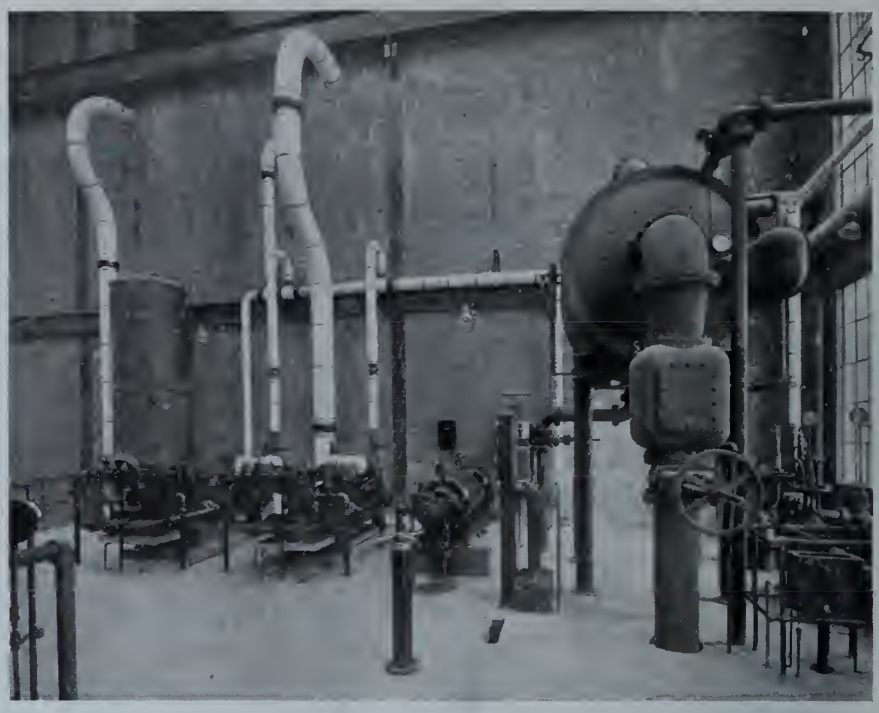


FIG. 7. WEST SIDE OF PUMP ROOM SHOWING BOILER FEED PUMPS, FEED WATER HEATER, AND HIGH PRESSURE HYDRAULIC PUMPS.

The 12-in. exhaust steam header is carried the entire length of the pump room basement and collects the exhaust from all the pumping units, and discharges into the feed water heater, or is by-passed to the atmosphere. The exhaust steam header is of standard steel construction with steel flanged fittings. The exhaust pipe from one pump and the by-pass from header consist of spiral riveted wrought iron pipe.

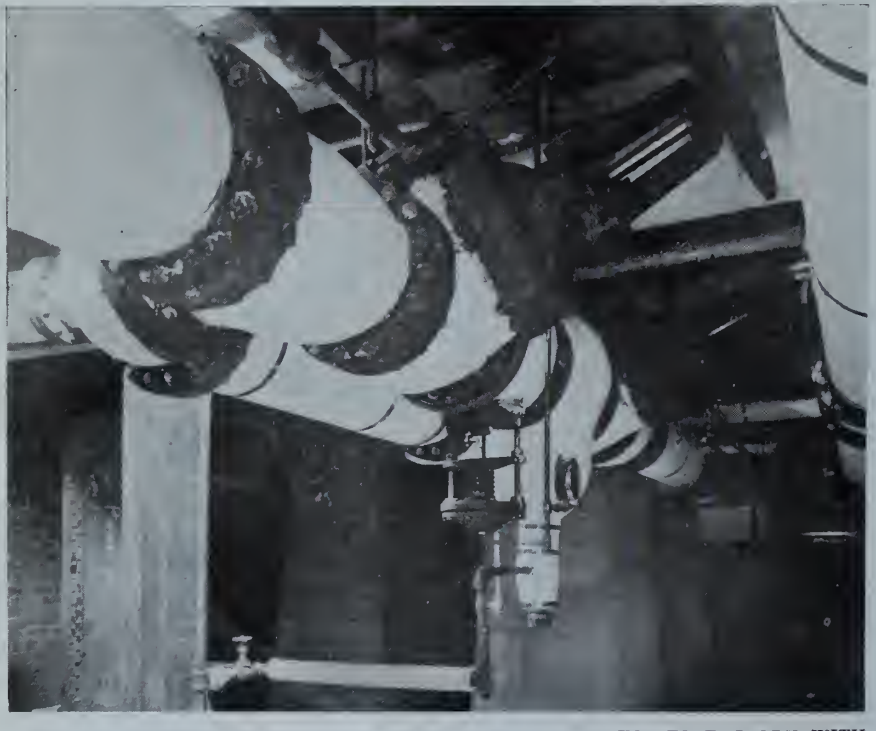


FIG. 8. PUMP ROOM BASEMENT SHOWING MAIN STEAM LINE TO FACTORY WITH SEPARATOR, REDUCING VALVE, AND BY-PASS PIPE.

All the fittings which carry boiler pressure are of cast-steel and have Vanstone joints, both fittings and bends being supplied by the Walworth Co., Boston, Mass. All the reducing valves were supplied by Kielly & Mueller, and the steam traps by V. D. Anderson & Co., Cleveland, Ohio. All piping carrying high pressure is covered with 85 per cent., 1½-in. sectional magnesia, with the exception of the tanks, vulcanizers, etc., which are covered with 85 per cent. magnesia block. The exhaust steam piping and low pressure heating line are covered throughout with 1-in. sectional air cell. All covering is painted with two coats of lead and oil, and is finished with brass bands, the whole presenting a neat and workmanlike appearance. The pipe covering was supplied by the Canadian Johns-Manville Co., and was installed by Bennett & Wright.

All the high pressure valves are cast steel and were supplied by the Lunkenheimer Co., as were also the non-return valves on the boilers. All clean returns from the factory discharge into two hot wells under the pump room floor. Make-up water is also supplied to the hot wells in sufficient quantity to take care of losses.

Hydraulic Piping System

The raw water which is pumped from the lake is carried in a 12-in. main to the pump room to supply the various pumps, tanks, etc., or direct to the factory supply main. A line is carried from the inlet main to a 6-in. turbine booster pump which supplies water to the factory for general purposes at 125 lbs. per sq. inch. A second connection goes to the fire pump, a third to the low pressure hydraulic pump, and a fourth to the boiler feed make-up water. A 250-lb. pressure line is carried from the low pressure hydraulic pump to the

presses in the factory, while another line carrying 1,500 lbs. pressure is taken from the high pressure pump, also to the presses. The high pressure service is used for operating the presses and the low pressure service for putting the presses in position for operating.

A 4-in., 50-lb. pressure line is carried to the factory for the plumbing system, while a 2½-in. suction line is taken from the 250 lb. water service line to the hydraulic pump which boosts the pressure to 1,500 lbs. A balancing line is taken from the balancing tank in pump room to obtain uniform pressure on the system. The high pressure pumps operate in conjunction with a hydraulic accumulator also located in the pump room. There is a 2½ inch line connecting the balancing tank with the air compressor. The material used in the low pressure lines is extra heavy steel pipe with cast iron fittings. For the lines carrying 250 lbs. and upwards, extra heavy steel pipe and cast steel fittings are used. Crane cast steel valves are used in the 1,500 lb. lines, and Lunkenheimer valves in the lines carrying pressures below this.

The Blake-Knowles fire pump delivers from the 12-in. intake supply line to the stand pipes in the factory and also to the sprinkler tank. It will also pump water from the storage reservoir to the fire system. The booster pump is connected up to deliver water to the factory for general purposes or to the fire system, taking the water from the incoming line or from the storage reservoir. The two low pressure hydraulic pumps are connected up so that they can be used for boiler feeding in case of emergency. All hydraulic returns are collected in a tank and returned to the pumps.

Heating System

The heating arrangements for the factory are on the low pressure vacuum return system which has been designed to give a temperature of 70 degs. at 10 deg. below zero, Fahr., with maximum wind pressure. In designing the system particular care had to be taken to allow for the large area of glass and somewhat high wind pressure on account of the exposed location of the factory. There is a total of approximately 40,000 sq. ft. of radiation. The building is warmed throughout with wall radiators placed below the windows, each radiator containing an average of 200 sq. ft. of radiating surface. On the supply end of each radiator is a Jenkins valve and on the return end a Dunham vacuum trap. The radiators are hung with special wrought iron brackets which are built into the wall. They are in two feet wall sections, are of new pattern, and were supplied by the Dominion Radiator Co., Toronto.

The distributing mains for the heating system are carried on the second floor ceiling, while risers take care of the third and fourth floors, with drop risers for the floors below. The vacuum return system is carried along basement ceiling to the tunnel and back to the vacuum pumps in the pump room. The roof monitors are taken care of by 1¼ and 1½ inch pipe coils, there being twelve coils containing 10,500 feet of pipe complete with headers, elbows and supports. The coils are arranged so that the entire bank can be cut off by a valve placed on the floor line. The pressure is reduced from 100 lbs. to 30 lbs. and then from 30 lbs. to 2 lbs. by reducing valves which are situated in the factory basement near the tunnel. The entire heating system was designed and executed by Bennett & Wright.

The original plans did not call for a steam heating installation in the power house as it was thought to be unnecessary. Owing, however, to the efficiency of the steam pipe insulation, it was finally found necessary to heat the building. In the power house there are 2,700 feet of radiation. The heating system is similar to that installed in the factory. The cement house and spreading house have a total of 1,500 feet of radiation, and the same system is installed in these two buildings as in the main factory building. The only variation is that the radiators were supplied by Steel & Radiation, Toronto, instead of by the Dominion Radiator Co.

Electrical Installation

There are a number of interesting features in the electric power and lighting installation. The company takes power from the Hydro System but considerable direct current power is also required for a number of the factory motors. The equipment in the motor generator and transformer room will be taken together in the description given below, being naturally dependent upon one another. In the motor generator room, provision has been made for an additional unit which may be installed in the near future. Runways have also been provided for an electric traveling crane which however has not as yet been installed. The accompanying illustration shows the switchboard gallery which is 14 feet wide and extends the entire length of the room. It will also be observed that there is a rolling door for each room; these were supplied by the A. B. Ormsby Co., Toronto.

Transformers and Switches

The plant receives 3 phase 25 cycle power at 2200 volt through an overhead line from the Hydro sub-station a short distance from the company's power house. The line enters the building at the transformer room. The system is protected by a set of Westinghouse type AK electrolytic lightning arresters. These are mounted on a gallery about 25 ft. from the floor. Disconnecting switches are also here provided for cutting off the entire supply. On the main floor of this room there are installed four 150 KVA. O. I. S. C. transformers, 2200/550 volts. Three of these are ordinarily used connected in delta, the fourth being a spare unit which can take the place of either of the others in case of breakdown. On a pipe structure immediately above the transformers there is mounted a set of disconnecting switches for both the high and low tension side of each transformer, and, over the spare transformer, these switches are double throw and connected in such a manner that the spare transformer can be put into service by simply closing the proper switches.

Directly opposite the transformers in the same room is located the 2200 volt switch structure. This consists of the usual pipe framework with a laminated copper bus running along the top. Beneath this are mounted all the electrically operated remote controlled oil switches which control the various outgoing 2200 volt feeders to the factory, and also the primary of the transformer bank. Between the oil switches and the bus there is a set of disconnecting switches on each circuit, and at the end

FIG. 9. MOTOR-GENERATOR ROOM WITH SWITCHBOARD GALLERY AND 550-VOLT SWITCH STRUCTURE UNDERNEATH THE D.C. BOARD AT FAR END.

of the structure the main incoming line switch, which is also electrically operated, is located, likewise the disconnecting switches.

There is also mounted adjacent to this structure another set of Westinghouse type AK electrolytic lightning arresters which are connected directly to the 2200 volt bus. All series transformers are connected in on the load side of the circuit breakers and immediately above the potheads on the end of the lead covered cables. The cables pass from here down through the floor into the underground duct system, which will be spoken of later.

A.C. and D.C. Switchboards

Next to the transformer room there is the motor-generator room which also contains the operating gallery on which is mounted the nine-panel a.c. switchboard, and five panel d.c. switchboard, both of Westinghouse manufacture. The material used on both these switchboards is black marine slate, having a total height of 7 ft. 6 ins., composed of one panel 25 ins. high, and another 5 ft. 5 ins. high, supported on angle iron frame work. The width of the panel varies according to the amount of apparatus mounted thereon, but none are less than 20 ins. wide. The thickness of the slate is 2 ins. and each panel has the edges of the slate beveled. The a.c. board controls all the 2200 and 550 volt circuits and the incoming line switch. As all these switches are remote controlled and electrically operated, only the controls and the indicating lamps are mounted directly on the switchboard.

A totalizing panel is provided which contains a Westinghouse graphic recording wattmeter, graphic recording frequency meter, graphic recording power factor meter, and graphic recording voltmeter. At the left-hand end of this board, on a swinging bracket, are mounted a voltmeter and an indicating power factor meter, the voltmeter being arranged so that it can be plugged on to any one of the three phases, and the power factor meter arranged so that by inserting a plug into a receptacle provided on each one of the feeders, the power factor of that load may be read. The relays protecting all the circuits on this board are Westinghouse type B shunt trip, and are located on brackets at the back of the board.

Motor Generator and Connections

In a plant of this kind it was found advisable to use direct current motors on the calenders, and for supplying this load there has been installed a Canadian Westinghouse motor-generator set. This is a three-bearing machine, consisting of a 510 h.p., self-starting synchronous motor, 3 phase 25 cycle 2200 volt, direct connected to, and on a common bedplate with, a 350 k.w. 230 volt 3-wire d.c. generator. The speed of the set is 750 r.p.m., and there is a 6 k.w. exciter mounted on the end of the shaft for exciting the synchronous motor. Balance coils are provided capable of carrying unbalanced load up to 50 per cent. of the generator capacity. The d.c. leads from the generator are carried through conduit up to the back of the d.c. switchboard on the gallery, where the usual switches and circuit breakers are provided.

The starting panel for the synchronous motor forms part of the d.c. switchboard. On it are mounted two controllers and three signal lamps, which work in conjunction with three electrically operated oil switches on the switch structure immediately below the gallery. This panel also mounts relays, a field switch, and two ammeters, one in the field circuit of the synchronous motor, and the other in the primary circuit. To the right of the d.c. generator panel there are two d.c. feeder panels consisting of 800 amp. carbon circuit breakers, ammeters and knife switches. The last panel on this switchboard is for controlling a 25 k.w., 125 volt, General Electric Co., turbo-generator, which is used for emergency lighting in case the power should be off. On a swinging bracket at the right-hand end there is mounted a 300 volt d.c. voltmeter.

Switch Structure Details

The switch structure, which is mentioned as being underneath the switchboard gallery, in addition to mounting the oil switches for the synchronous motor, also has mounted on it the 550 volt electrically operated oil switches. These are fed from an overhead bus through disconnecting switches, and the entire structure is very similar to the 2200 volt structure in the transformer room. Altogether there is a total of 18, either 2200 volt or 550 volt Westinghouse type B electrically operated remote controlled oil switches in this plant.

By the use of these switches the Goodyear Co. have been able to concentrate all their controllers on a comparatively small switchboard which would not have been possible had they mounted the oil switches directly behind the switchboard panels as is so often done in installations of this kind. On all parts of the electrical equipment there has been provided ample room for future extension. Both switch structures can be extended a considerable distance; and there is room for two more motor-generator sets as well. Both a.c. and d.c. switchboards can be extended in either direction, and the a.c. switchboard is even now provided with two blank panels which can be equipped with instruments and controllers when the occasion arises.

All the cables leaving the power house are three-conductor, cambric insulated, and lead covered. These pass through an underground duct system consisting of about sixty 3-inch fibre conduits, to a brick cable vault located at about the centre of the factory building in the basement. From here the various cables are distributed. The 2200 volt cables to the large motors run direct through in iron conduits. The other circuits, consisting of 550 volt power and the direct current circuits change to rubber insulated braid covered cable, run in iron conduits, to the various machines or distributing points.

FIG. 10. VIEW OF TRANSFORMER ROOM. 2200-VOLT SWITCH STRUCTURE ON THE RIGHT AND TRANSFORMERS ON THE LEFT.

Lighting Details

The lighting of the factory is taken care of by three 35 k.w. oil insulated single phase transformers, located in a sub-station in the basement of the factory. In this room there is also a 2200

FIG. 11. BACK OF D.C. SWITCHBOARD SHOWING ARRANGEMENT OF BUSES.

volt oil switch for controlling the primary, and a number of knife switches and fuses for controlling the secondary circuits. This apparatus is mounted on two black marine slate panels of standard height and dimensions. A 6-wire cable bus is run from the low tension side of the transformers over the top of the switchboard panels, and connected to the laminated copper bus which distributes power to the various lighting circuits.

Factory Motors and Equipment

The various lines of mixing mills, warming up mills and washing mills in the factory are driven by Westinghouse type CCL squirrel cage induction motors, 3 phase, 25 cycle, 2200 volt, 500 r.p.m., 2-bearing pedestal type, there being three of 400 h.p., one of 300 h.p., and one of 200 h.p. These are each direct coupled to a reducing gear by means of a Cutler-Hammer magnetic clutch coupling, which in turn is connected with a safety switch located over each mill, so that in case of accident the operator may by tripping the safety switch disengage the magnetic coupling which operation also sets two magnetic brakes, one connected to the motor shaft, and the other to the reducing gear shaft, and also opens the motor switch, so that the whole outfit is immediately brought to a standstill.

The starting panels for each of these large motors are in each case located just a few feet away from the motor. In addition to a double-throw starting oil switch for the motor, and a double-throw oil switch for reversing the motor in case of necessity, there is also mounted the relay apparatus for controlling the brakes and clutch couplings. An ammeter connected in the primary circuit of the motor completes the equipment of these panels. The apparatus at the back of the panels is neatly enclosed in a steel housing, with a ventilator at the top. The auto-transformers and cable terminals, etc., are also mounted within this housing.

For driving calenders there are provided three 75 h.p. variable speed direct current motors. These are of steel frame pedestal type construction, and are equipped with interpoles. They are operated from the 3-wire 115-230 V. system and have a range of speed from 375 to 750 r.p.m. The various speeds on the lower range are obtained by connecting the motor to the 115 volt leads, and by using control. The higher speeds are obtained by connecting the motor to the 230 volt leads, and also using field control. The control panels, which are of Cutler-Hammer manufacture, are mounted directly beside the calendars, and are operated from a master controller mounted right on the calender frame.

In addition to the equipment mentioned above, there have been installed at various points in the factory, a large number of smaller sized induction motors, mostly of Canadian Westinghouse manufacture. Some of these are started with the Westinghouse type K auto-starters and some of them in the smaller sizes are provided with a Westinghouse type H oil circuit breaker.

In case of the failure of supply from the Hydro, the 25 kw. turbo generator is connected through 3 pole d.t. automatic switches to feeders on all floors to supply necessary lighting to complete any operations requiring immediate attention such as vulcanizing, etc.

The main equipment was supplied and installed by the Canadian Westinghouse Co., Hamilton, Ont.; the bus bar equipment by the General Devices & Fitting Co.; the wires and cable by the Standard Underground Cable Co., Hamilton, and the Northern Electric Co., Montreal. The wiring for lighting and 550 volt power was installed by G. J. Beattie, Toronto.

Electric Lighting Installation

The electric installation for the lighting of the factory is fed from the three 40-k.w. single-phase transformers already mentioned, these being connected in double delta to obtain a 3-wire, 230-115 volt, single-phase system.

From the switchboard in basement sub-station, two sets of three wire mains run to each floor in conduit, changing into open wire at second bay on either side of the centre of the building. The three wires run the entire length of the building on E. E. E. bus insulators mounted on beam clamps to lower web of each I beam, and slack is taken up by strain insulator and J bolts at each end. On the mains in the basement is the only place where conduit has been used, junction boxes being placed at short intervals to allow of alterations and additions.

The circuits are fed from 4-circuit, 2-wire fuse cabinets placed about 10 ft. from the ground on the columns (to prevent unauthorized persons tampering with fuses). From the cabinets the branch circuits are run in conduit to centre of distribution of each circuit, changing into cleat wiring, split knobs mounted on Universal beam clamps, being used to support the wiring as it passes across the I beam from bay to bay; this method of wiring gives a very flexible arrangement, allowing alteration of position of lights to be made quickly and economically.

Nitrogen lamps of 100 watts, with Abolite shades and shock absorbers, have been used in basement, second, third and fourth floors, while 200-watt nitrogen lamps, with suitable shades, are in-

FIG. 12. EXTERIOR VIEW OF FACTORY AND POWER HOUSE, WEST END.

stalled on first floor, which has a high ceiling. General illumination has been used mostly throughout the factory, except in spaces set apart for tire manufacture, etc., in which group lighting suitable to the various operations has been installed.

In the power house, owing to the height of the roof, 500-watt nitrogen lamps, with distributing shades, are utilized, with the addition of bracket lights around walls in generator room, pump room, and boiler room. Approximately 24 miles of rubber-covered wire and cable have been installed, together with seven hundred 100-watt, one hundred 200-watt, and twenty-five 500-watt nitrogen lamps of Westinghouse manufacture.

THE INVENTION OF THE STEAM HAMMER

NASMYTH invented his huge steam hammer to forge the paddle shaft of the Great Britain on Nov. 24, 1834, but Brunel recommended the screw propeller after the trials of the Archimedes by Francis P. Smith, and this upset all the arrangements for the use of the hammer, but the iron trade which had been slack for some time revived and Nasmyth used and patented his hammer in 1842 after his return from France. The hammer was so accurately made that he showed the Lords of the Admiralty at Devonport Dockyard, how a blow could be made so gentle as to crack the end of an egg placed in a wine-glass, as if done by an egg-spoon, and the next blow so violent as to rattle all the china in a home a quarter of a mile distant.

Another of Nasmyth's inventions was riveting by compression. One wet wintry Sunday afternoon he went to his workroom to perform some repairs to a small stone which required to be riveted, and as the noise of riveting might be heard he solved the difficulty by using the jaws of his bench vice to press in the hot rivets. This system of riveting was long afterwards patented by Smith of Deanston, with William Fairbairn of Manchester. It is extensively used in boilers, girders, and all other wrought-iron structures where sound riveting is absolutely essential, and by hydraulic power a considerable portion of iron shipbuilding is carried out by the silent squeeze system in place of hammers. When Nasmyth continued the silent and very effective method of riveting he named it "The Sunday Rivet."

MAN POWER BIGGEST FACTOR IN INDUSTRY

WHAT is going to happen if the output of steel is not increased? The fate of the war depends largely upon the steel production of the United States, and the out-turn is being seriously retarded by lack of fuel, iron, transportation facilities and labor.

The seat of the trouble which is hampering production at this time is labor. There are not enough men to man the steel plants. There is also not sufficient fuel to operate them for the same reason, and the facilities of transportation have proven entirely inadequate to the extra strain. The consequence has been that production instead of increasing is declining, and the out-turn of some mills is reported to have been reduced to 50 per cent. of normal capacity.

As for iron, the outlook is still more serious. The lack of man power is holding up production of ore, of fuel, and consequently of iron and steel. In the Eastern market recently there were inquiries for upward of 25,000 tons of basic and foundry iron. The great bulk of this demand must disappear because there is nothing with which to satisfy it. It is estimated that of the tonnage asked for probably not more than 5,000 tons will be found available for distribution.

The inquiries are for large and small lots for delivery from now to next July. The furnaces are also growing cautious about extending their engagements for next year, as they are already well sold up and behind on their present contracts for the year. Steel makers and foundry men are clamoring for iron all over the country, and the market has probably never before been subjected to such a combing process with so little tangible result. It is well for industry in general that the price is fixed or the market would undoubtedly be thrown into an unprecedented state of panic.

PRECAUTIONS NECESSARY FOR THE MAINTENANCE OF CRANE RAILWAYS

OUTSIDE crane runways seem to be less rigid than inside runways, possibly because of the fact that the building itself provides some support and thus gives more rigidity to the columns or uprights. Outside runways are also exposed to all conditions of weather, and for this reason as well as because of the constant strains and vibrations, they should receive careful inspection. In case defective members are observed they should be immediately replaced or repaired. Any corrosion or rusting that is observed should be checked by scraping or cleaning off rust and applying a proper protective coating. Runaways that have been in service for a number of years often sway quite noticeably, and sometimes to such an extent that the additional stresses thus produced are dangerous. If this condition exists repairs should be made or reinforcements should be applied, sufficient to restore the runway to its original strength and rigidity.

Effective safety inspection would prevent many of these dangerous conditions, and it should be thorough, regular, and careful. The inspector should not only submit recommendations for the safeguarding of the machines, which is one of his special duties, but he should also consider the possible failure of weak crane structures, spreading or creeping rails and columns, uneven settling of column foundations, and any other trouble that might disturb the proper alignment of runway tracks.

MORE FUEL OIL FOR STEAMERS

AN important change which has been comparatively lost sight of owing to the stress of war conditions is the increasing use of crude oil as fuel for steamships. Without a great deal of publicity having been given to the fact, a not unimportant portion of the American merchant marine has been turned into oil burners. The navies of the world, of course, have been using oil as fuel much longer than the merchant services. In this connection it may be noted that at a recent conference held at Washington between representatives of the American and British governments. Standard Oil officials and the Shipping Board, an ample supply of oil for the British navy was assured.

The chief advantages claimed for oil as fuel are a saving of bunker space in the ship and a saving of dead-weight. Up to comparatively recent years the drawback has been the price of oil, but with the unprecedented enhancement in the price of coal which war conditions have brought with them the economic opportunity to use oil has presented itself. Speaking generally the increase in the Texan, Mexican, and Californian oil supply which has taken place during recent years has made possible a greater use of oil for generation of steam on ships. Hitherto oil was usually too valuable to be used in ships furnaces.

Particularly on the Pacific Coast and in trade with the Orient has the war promoted the use of oil as fuel on ships, the source of supply in the Gulf region and California being relatively near at hand.

Five steamers now in course of construction for the New York- Valparaiso service are to be oil burners. Eighty per cent. of the Standard Oil steamers now afloat are equipped as oil burners. The Southern Pacific Railway, which has oil fields of its own, has been the leader in this country in the use of oil fuel for locomotive engines. In 1915 the company had 1,927 oil-burning locomotives out of a total of 2,046 engines. The Southern Pacific is also using oil as fuel for its steamers to a very considerable extent.

The Luckenbach Steamship Co. has a couple of oil-burning steamers. There was launched last month at the yards of the Fore River Shipbuilding Co., Quincy, Mass., a large oil-burning freighter of 10,000 tons dead-weight intended originally for the Luckenbach Steamship Co., but now taken over by the Government. The fuel oil is carried in the double bottom and in the forward and after peak tanks.

The Atlantic, Gulf & West Indies Steamship Lines have seven or eight oil-burners. Most of the newer ships have been equipped to use liquid fuel, the policy being to build all new ships with facilities for the use of either coal or oil. The Munson Line has two or three oil burners of 7,500 tons dead-weight, and other American companies have one or more vessels equipped in this way, as for instance the United Fruit Co. Some of the Cunarders will also be oil-burners.

Comparison of Working Costs of Principal Prime Movers*--II

By Oswald Wans

High thermal efficiency does not necessarily imply commercial superiority. Available data are seldom complete and render difficult the justification of claims and working costs advanced by advocates of respective prime movers. The engine of lower thermal efficiency may, therefore, under certain conditions, be the sounder proposition commercially.

THE quantity of lubricant necessarily varies widely in practice, even in similar engines, due partly to the differences in manufacture and to the care or negligence on the part of the attendant. To cover amply these factors, the charges should be of a liberal nature.

The accompanying curves, Fig. 4, give representative consumptions for new oil, no allowance having been made for filtering and re-using the oil. The saving effected by filtering is worthy of consideration, for it is possible by this means to reduce materially the oil bill. It should be noted, however, that filtered oil cannot be recommended for use in cylinders, unless enriched by about 30 per cent. of new oil. It will be observed that as the total quantity of oil is given, it must include both cylinder and bearing oils. For internal-combustion engines, it is customary to use one grade for both purposes, whereas two qualities are usual for steam-engines in which approximately one-third of the total quantity will be required for the cylinders and that remainder for bearings, etc. The adoption of one grade of oil has a practical advantage in preventing the use of the wrong oil for, say, the cylinders, a mistake likely to have serious results in an oil or gas engine.

Water Supply

In many localities a plentiful and gratuitous water service is not available, and the cost of the necessary supply becomes a matter of moment. With a free and suitable supply the water may be returned, directly after use, to the source, thus obviating the cost of a cooling plant. Frequently, however, the local charges render necessary a closed system whereby, with little loss, the water can be used repeatedly. For the smaller internal-combustion engines, up to 50 b.h.p., cooling tanks are very general, but for larger powers a cooler, of, say, the tower type, becomes necessary. The tower cooler is equally applicable for cooling condenser water and possesses the advantage of simplicity and low cost, but owing to its bulk is not always adaptable. When the requisite space is not available, a more costly form of cooler may be a necessity, but such cases are not general and must be considered individually.

In the Expenditure Curves, Fig. 1 (page 309), the cost of a cooling tower is included for international-combustion engines above 50 h.p. and for surface, but not jet condensing steam-engines. In the latter case it is assumed that the water is run to waste. The water lost by evaporation, in passing through the cooler, may be taken as 5 per cent. of the total water in circulation.

There may be a further loss due to leakages, but in a well-kept installation the loss on this account is negligible. This cooler loss holds good for steam-engines and internal-combustion engines, but there is a further loss in a suction-gas plant in the water required for supplying steam to the gas-producer and in the effluent from the cleaning plant. The former water is of course not recoverable, and the latter can be and is sometimes used several times before disposal. Unless special provision is made, the water is prone to foul the circulating pump and pipe-lines, and, when ultimately disposed of, is apt to arouse suspicion in the municipal mind owing to its more concentrated nature, and this applies particularly to wood refuse fuel.

Often the cleaning water can be taken continuously from and returned to a neighboring pond or river without charge. It may be remarked that the effluent after once passing through the cleaning plant is of a harmless nature, and if turned into a sewer or a river all traces of tar must be removed, as this appears to be the bete noire of local authorities.

The following table (page 342) gives the total quantity of water in service and the make-up water necessary to replace the cooler and cleaning plant losses. The latter quantities only need be considered in working costs, for the cost of the initial supply of water is negligible.

Sundry Stores

The payments arising from these items are small, and are generally covered by a charge of 0.01d. per rated b.h.p.-hour for any of the prime movers under consideration.

Labor

The charges under this heading should include not only the attendant's time during running hours, but also that needed to clean, grind in valves, etc., and generally to keep the installation in good condition. In the case of steam and suction-gas plants the time spent in handling the fuel and removing the ashes must be covered. The attendance time is fairly uniform for similar installations, and generally speaking is on a minimum basis. Usually it is not necessary to employ highly skilled labor, nevertheless sufficient should be paid to command the services of the intelligent

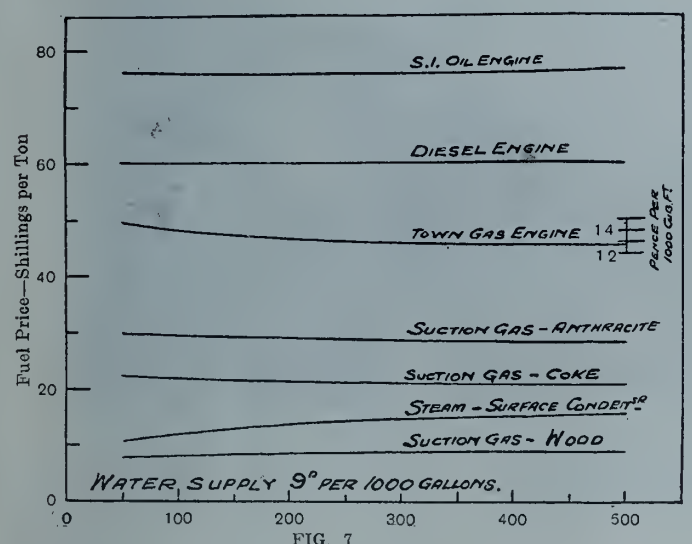


FIG. 7

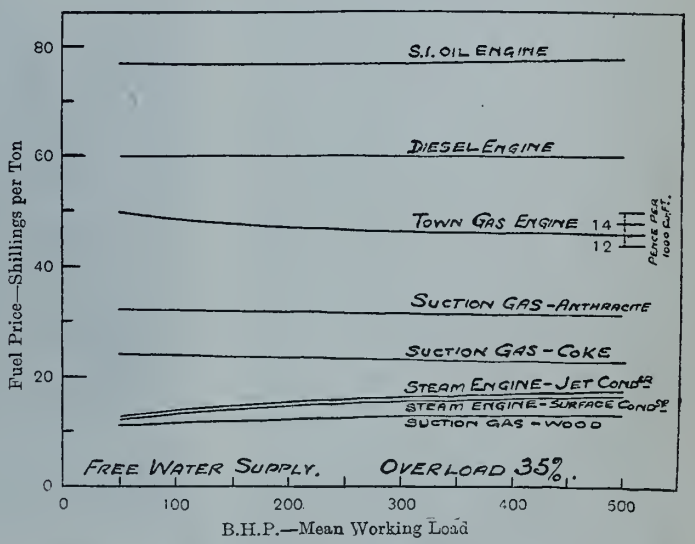


FIG. 8

*Read before the Institution of Mechanical Engineers, London, Oct. 19, 1917.

and handy type of man. Wages at the rate of 6d. per hour have been allowed for in the cost curves, Figs. 5 and 6.

Water Consumptions.

Installations	Surface Condenser Water Gals. per b.h.p.-hour	Jacket Water Gals. per b.h.p.-hour	Piston and Exhaust Valve Gals. per b.h.p.-hour over 100 b.h.p.	Scrubber Water Gals. per b.h.p.-hour	Dust Collector Gals. per b.h.p.-hour	Tar Extractor Gals. per b.h.p.-hour	Steam to Producer Gals. per b.h.p.-hour	Water Lost by A, B, C, D	Water Lost by Cooler Evaporation	Total Water Lost Gals. per Working Load b.h.p.
				A	B	C	D			
Steam engine.....	45-55	..	..	...	..	..	....	....	2¼-2¾	2¼-3¼
S-I Oil Engine.....	....	6	0.5	...	..	..	....	....	0.325	0.325
Diesel Engine.....	....	5	0.5	...	..	..	....	....	0.275	0.275
Gas Engine:—										
Town Gas.....	....	6	1.5	...	..	..	....	....	0.375	0.375
Anthracite and coke	....	6	1.5	1.75	..	..	0.075	1.825	0.375	2.2
Wood, etc.....	....	6	1.5	...	4	1.5	....	5.5	0.375	5.87

The following formulae give a fair indication of the time that is spent solely upon the prime movers within the scope of this paper:—

Suction gas (wood fuel) and steam engine plants .....0.8 + 0.0047 b.h.p.
Suction gas (coal and coke fuel)..0.6 + 0.0041 b.h.p.
S.I. and Diesel engines.....0.3 + 0.0036 b.h.p.

These expressions give the labor in hours per rated working load per hour. Thus for a 100 b.h.p. suction-gas plant using wood fuel, and 100 b.h.p. town-gas engine, the labor would be respectively 1.27 and 0.37 hours per hours run.

Repairs

The annual charge should provide amply for wear and tear and such breakages as are not covered by insurance. The actual annual payment may form an appreciable portion of the running costs, and must in some cases exceed the estimated amount in view of the small provision made. This applies particularly to internal-combustion engines. There is little difficulty in citing instances of gas and oil-engines in which the repair bill over, say, 5 or 6 years, has not exceeded 2 per cent. per annum of the engine cost. Such a figure, however, should not be taken as a basis. If the cost of repairs were entirely dependent upon wear and tear, 2 per cent., there is no doubt, could be taken as a general rate.

Although internal combustion engines have proved themselves to be thoroughly reliable in service, it is nevertheless a fact that they are more prone to minor mishaps than steam engines, and due allowance must be made for a well designed gas or oil-engine, ample margin for this contingency is given by an annual charge of 3 per cent. of the engine cost.

The following are the repair charges allowed for in the Working Cost Curves, Figs. 5-6:—Diesel and S. I. oil engines, town gas engines—3 per cent. of engine cost; suction-gas installations, 3 per cent. of engine and producer costs; steam installations, 2 per cent. of engine, boiler and auxiliary costs.

From the facegoing data it is possible to estimate with reasonable accuracy the annual working costs of the engines under consideration. These costs will be found to differ appreciably with the locality, due mainly to the fluctuations in the prices of water and fuel. The cost of lubricating oil and labor may vary but not sufficiently to affect materially the annual charges. Further, the variation would be common to all installations, so that the relative working costs for practical purposes would be unaltered. The position with regard to the water and fuel supplies however, is quite different. In some districts a free water supply may be available, and in others the charge may be high, whilst the price of fuel, particularly oil, varies considerably from time to time and with the locality, thus rendering these two items almost the ruling factors of economical working.

In order to establish a relationship between the fuel prices that may be paid, and to show the influence of the water charges upon these prices, the curves, Figs. 5 and 6, have been plotted. The curves A to F, 5, give the annual charges with water at 9d. per 1,000 gallons, and in Fig. 6 it is assumed that the water supply is free, but none of these curves include the cost of fuel. The curves G represent the total annual working cost of a Diesel engine using fuel-oil at £3 per ton. It follows, therefore, the total amount that may be spent annually upon fuel to give even running charges for any one of the remaining installations is represented by the length of the ordinate between the curve G, and the cost curve of the particular engine considered. From the total fuel cost thus obtained, the maximum prices that may be paid can be easily computed, and have been plotted in curves Figs. 7 and 8, whilst the fuel prices given by those curves for plants of 250 b.h.p. mean working load are given below:—

	Price of Fuel Curve Fig. 7 per ton	Price Ratio	Price of Fuel Curve Fig. 8 per ton	Price Ratio
Diesel engine.....60/		0.79	60/	0.785
Solid injection oil engine 76/		1.0	76/6	1.0
Suction Gas:—				
Anthracite 29/		0.38	31/6	0.41
Coke 21/		0.27	23/	0.3
Steam Engine:—				
Wood 8/6		0.113	12/	0.157
Jet Condenser		...	16/	0.21
Surface Conden..14/		0.184	15/	0.195
	per 1000 cu. ft.		per 1000 cu. ft.	
Town & gas engine 1/1		0.014	1/1	0.014

In the curves, Figs. 5 to 8, the engine possessing the highest thermal efficiency, namely, the Diesel engine, has been taken as a convenient basis using fuel oil at £3 per ton. Reference to these curves shows that the relative fuel prices for the several installations are fairly uniform for the range of power under consideration. The widest variation is that shown for the steam plants due to the comparatively higher initial cost and lower thermal efficiency of the smaller powered engines. It should be noted that the fuel consumptions represented by the curves, Fig. 2, are favorable to the steam-engine and apply to compound condensing installations using superheated steam, that is to say, they are best practice figures. It may be said with certainty, therefore, that, in general practice consumptions as much as twice those represented are not unusual, thus nearly halving the fuel prices shown by the fuel price curves, Figs. 7 and 8, and further limiting the districts in which the use of the steam-engine can be defended on the score of minimum working costs.

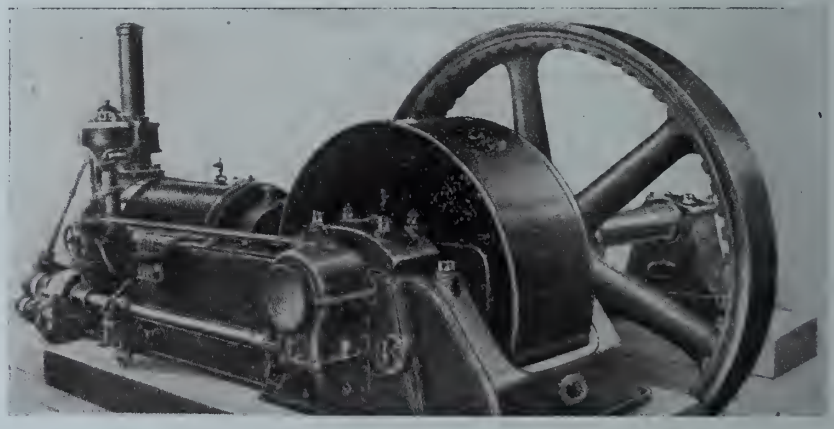


FIG. 9. SOLID-INJECTION HIGH-COMPRESSION OIL ENGINE

As the power increases a higher price may be paid for coal, and the steam-engine becomes a more serious rival of the suction-gas plant; nevertheless, for installations up to 500 b.h.p. working load the latter well holds its own, for it is possible to obtain even running costs with fuel ranging in price, according to the power, from two to three times that permissible for a steam-plant. The price allowable for town-gas is practically constant at 1s. 1d. per thousand

cubic feet, and consequently confines the use of the town-gas engine to cities in which gas is procurable at this low rate.

Calorific Values Assumed		
Anthracite	14,500 B.Th.U. per lb.	
Coal (Boiler)	13,500 "	"
Fuel Oil	18,000 "	"
Wood Refuse	5,800 "	"
Town Gas	540 "	1,000 cub. ft.

Turning now to the high-compression solid injection-oil engine. A high price may be paid for fuel-oil, namely, £3 16s. per ton as compared with £3 for the Diesel engine, or a price some 26 per cent. higher, notwithstanding the higher thermal efficiency of the latter engine. The lower capital expenditure and other running charges of the solid injection-engine are responsible for this result. The future of the oil-engine must be obviously dependent upon a regular supply of uniformly low-priced fuel-oil, and it is to be feared that past irregularities in these respects have to a certain extent militated against their more extended application.

Fuel Supply Problem

The problem of the supply of a uniformly low-priced fuel-oil is one that is well worth the serious consideration of the large oil companies, and it is satisfactory to note that during the twelve months prior to August, 1914, one companying had gone a long way to establish a feeling of security amongst users of oil-engines by offering fuel at an average price of £3 per ton, and were prepared to contract for a regular supply over several years. There seems to be every probability of these conditions again becoming general after the war. An adequate supply of fuel oil, in view of the high thermal efficiency of the oil engine, is of the utmost importance to be followed with advantage in the case of fuel oil.

With the fuel oil at £3 per ton, the price of coal must not exceed on the average £1 5s. and 12s. per ton respectively for suction gas and the larger steam plants over 250 b.h.p. in order that the total annual running charges do not exceed an oil-engine of the solid injection type, clearly indicating the wide field of action of this type of engine. The cheaper grades of fuel oil of not less than 0.95 sp. gravity alone are considered, as the charges of engines using the more costly and refined oils are appreciably higher and therefore commercially inferior. In Fig. 9, page 342, is shown a high-compression oil-engine of the solid-injection type, capable of handling the cheapest fuel-oils with an economy in conformity with the curves, Fig. 2 (page 309).

Considering lastly the refuse suction-gas plant, the price of the fuel ranging as it does from 11s. to 13s. per ton, even with a free water supply, limits its use to industries in which the wood or other refuse mentioned below is a waste product of the industry, for it is seldom possible to obtain a constant supply at these rates. Under this condition refuse installations are unquestionably the cheapest form of power. The illustration, not shown, shows the producer of a 300 b.h.p. suction-gas installation working entirely upon sawdust, shavings, wood blocks, etc. A producer of this type will also handle such refuse fuels as various kinds of husks and nut shells ,bark, spent tan, plum stones, etc.

The use of suction-gas as a heating agent is yet in its infancy, but very satisfactory results have already been obtained in laundries, woodwarking factories, tinsmiths' shops, etc. The gas is drawn from the producer through a purifier and pumped to a gas-holder, from which it is piped under slight pressure to any part of the factory, and by the aid of an air-mixer and burner used in a similar manner to town-gas. This feature is worthy of consideration, for it adds to the general utility of the suction-gas installation, and may in some cases effect an appreciable economy in the working costs. The plant, supplies gas for heating purposes in addition to that required for power. The possibilities of the system suggest many applications in which economies could be effected.

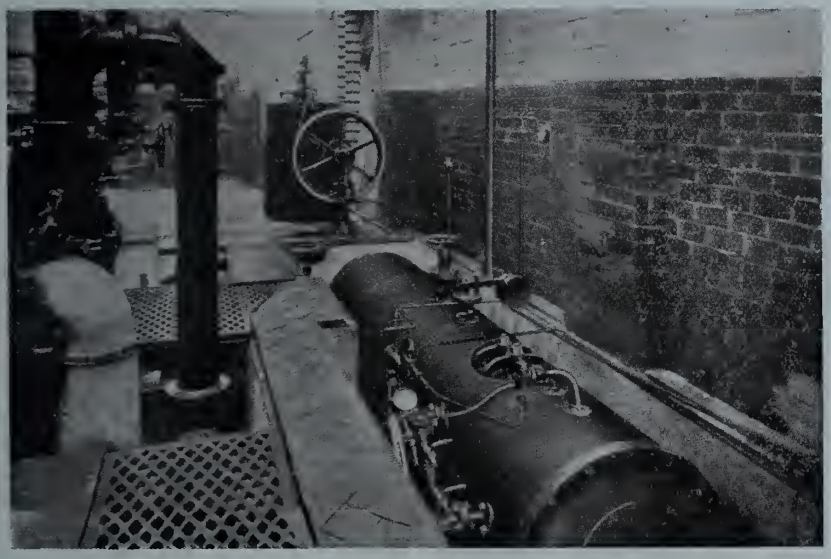


FIG. 10. BOILER HEATED BY EXHAUST FROM 250 BRAKE HORSE-POWER SUCTION-GAS ENGINE

manufacturers, for it offers a means by which minimum working costs may be obtained. It is usual in the supply of electrical and hydraulic energy for power purposes, for the suppliers to charge specially reduced rates, and it is suggested that a similar procedure might

An objection sometimes advanced against the adoption of the internal-combustion engine for certain classes of works as, for example, tanneries, laundries, cotton mills, factory heatings, etc., is its inability to provide a steam-supply. This difficulty has, however, been met to a large extent by the exhaust heated boiler which is capable of supplying about 2 lb. of steam, from and at 212° F. per b.h.p.-hour of the engine. The steam being generated from the exhaust heat that would otherwise be wasted may be truly stated as costing nothing beyond the small additional charges due to depreciation and interest upon capital. The illustration, Fig. 10, herewith shows a boiler working in conjunction with a 250 b.h.p. suction-gas engine, and is capable of supply about 500 lb. of steam per hour, which is equivalent to the saving of 65 lb. of coal per hour.

Conclusion

It is evident from the foregoing that statements to the effect that a certain class of engine is the most economical requires qualification. It has been shown that the cost of fuel has a deciding influence upon the working cost, although that due to the necessary water-supply may be serious in some districts. Now, as the cost of fuel is regulated largely by railway and shipping freights, it is clear that the distance from the source of supply has an important bearing upon the kind of fuel, and it follows the type of engine that should be installed.

The maximum permissible prices that may be paid in any locality are indicated generally by the ratios given, and more particularly by the curves, Figs. 7 and 8 page 341. The practical application of these price ratios shows that each type of engine has its particular field of action in which it can be used with commercial advantage, provided due regard is paid to the local conditions, or in other words, an exclusive claim to minimum working costs cannot be rightly made on behalf of any one of the prime movers under consideration.

The relative fuel prices do, however, indicate that the scope of the steam-engine is less than the oil-engine, for in the best practice of the former the price of coal for the larger installations of 250 h.p. and upwards may not exceed on the average one-fifth of the price of fuel-oil for an engine of the solid injection type and one-fourth for Diesel engines, and appreciably less for smaller powers. Between these extremes stands the suction-gas plant, for which the price of coal and coke may be respectively twice and 1½

times the price of coal for steam-engines of the larger powers. The use of town-gas engines is clearly confined to the few cities in which gas can be obtained at about 1s. 1d. per 1,000 cubic feet, and the refuse suction-gas installations to industries in which there is an ample supply of suitable waste material.

It is obvious, therefore, that the commercial superiority of a prime mover is not established by reference to its thermal efficiency, but by the local conditions regulating the price of fuel. From the purely engineering point of view this is not entirely satisfactory in that, however thermally efficient an engine may be, the ultimate test is a commercial one involving the market price of fuel, which must always depend upon the facilities for distribution from the source of supply. In practice, therefore, railway and shipping freights have a marked and direct influence upon the type of engine giving the most favorable performance from the commercial standpoint.

The whole problem is one that cannot but force itself more and more upon manufacturers with the keener competition that may be expected in the near future, and unless correctly solved must tend to handicap any industrial concern as the result of the higher establishment charges that must necessarily follow. The right solution not only benefits the manufacturer, but also affects an economy in the national resources by preventing the waste of fuel so frequently met with in practice, suggesting that minimum costs are either not sought or that the regulating conditions are not fully appreciated by those responsible.

BEFORE AND AFTER

By N. G. Near.

THE accompanying photographs show how modern equipment is doing away with the dust nuisance in industrial establishments. Fig. 1 shows how ashes

FIG. 1. BEFORE.

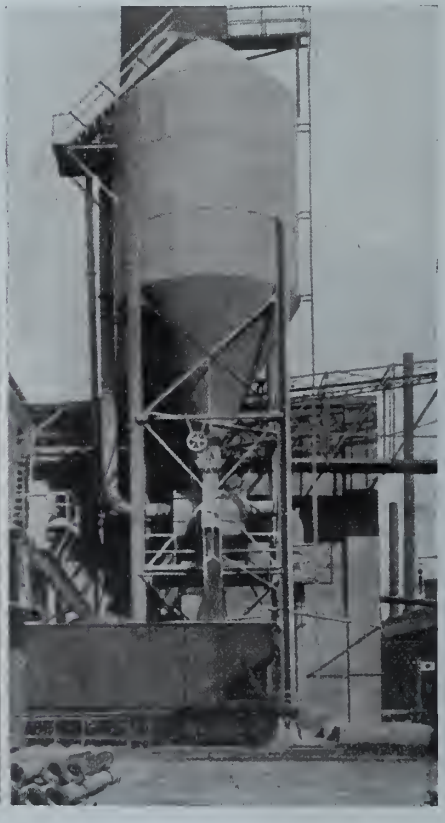


FIG. 2. AFTER.

were once loaded into a car by means of a clap-trap belt and bucket arrangement. It was often unendurable for the men to work in the vicinity of this loading machine under certain conditions—when the wind was just right and when it was real hot. This view was taken while the steel structure shown in Fig. 2 was being erected. The bottom of this steel structure is visible in Fig. 1.

Fig. 2 shows how the ashes are loaded now. There is not a bit of dust, because the ashes are well wetted down by simply turning the valve of a pipe line. The ashes are sucked into the tank in the same way that a vacuum cleaner works, and we all know how dustless vacuum cleaners are. The advance in efficiency is sufficiently obvious to render further comment needless.

RECENT DEVELOPMENTS IN POTASH PRODUCTION

THE influence which it is possible for the cement and iron industries to exert on the production of potash is of considerable importance at this time, and the possibility of this influence increasing in the future is the belief of Richard K. Meade, expressed in an article in the "Manufacturers' Record." The necessity for development work on this continent has been growing more urgent with the continuance of the war, some idea of the urgency being conveyed by the statement that the imports of pure potash from Germany before the war amounted to 250,000 tons, while 10,000 tons only were produced in the United States last year, as estimated by the Geological Survey.

Recent reports in Canada indicated the probability of production being increased by suitable treatment of feldspar in connection with cement manufacture. It seems, however, that the loss of potash by volatilization from rotary cement kilns was pointed out as far back as 1903, and that from blast furnaces still earlier, but before 1914 nothing was done to collect the substance from either source.

Some ten years ago a dispute arose between the orange growers in South California and the cement mills over the question of the damage caused by the dust from the mills being deposited on the fruit trees, and to settle the matter the Riverside Portland Cement Company installed a process for precipitating the dust by the Cottrell electrical system. This process not only proved efficient as a dust-catching device, but also collected the potash with the dust. Most of the potash being water-soluble, it can be dissolved out of the dust by leaching with water. Before the war the raw materials used at Riverside were low in potash, and hence the amount volatilized was small, but after the outbreak of war the company found they could increase the output of potash from their kilns by the aid of feldspar, which can be used without injury to the cement. They also found that mixing fluorspar with the raw materials increased the amount of potash volatilized to 90 per cent. of the amount contained in the raw materials, as against 50 per cent. volatilized under usual conditions. They next extracted the potash from the dust, and by crystallization obtained a potash salt containing at least 35 per cent. of potash. The crust which collects in the stacks of the rotary cement kilns contains from 6 to 12 per cent. of potash, and of this large quantities have been sold to the fertilizer companies since 1914.

In the summer of last year the Security Cement and Lime Company put the Cottrell process into operation in order to catch all their kiln dust. They found that the addition of salt to their raw materials increased the yield of potash, and at present they are obtaining about 20 tons of dust a day, averaging 10 per cent. of water-soluble potash. The Santa Cruz Portland Cement Company are recovering 700 lb. of potash daily from their kilns by a process of their own, and a number of other cement companies are installing or have installed Cottrell plant. When all these plants are in operation Mr. Meade estimates that they will yield about 10,000 tons of potash annually, and this amount, he states, could be very greatly increased by using feldspar as a raw material.

As to potash from blast furnaces, the only iron company in America, so far as he is aware, selling potash at present is the Bethlehem Steel Company. Up to the present only the dust which can be collected by means already at hand has been sold, the amount being estimated at about 4 per cent. of the total potash liberated; but the chemist of the company believes that apparatus could easily be installed to catch at least 50 per cent. of the potash now lost, and that the apparatus, so far from interfering with the operation of the plant, would benefit it through the better cleaning of the gas for the engines. It is estimated that of the potash volatilized in the blast furnaces the amount recoverable will average at least 10 lb. per ton of pig iron,

so that with an annual production of 25,000,000 tons of pig iron the blast furnaces of the United States would produce, say, 125,000 tons of potash.

PECULIAR RESULT OF COLLISION BETWEEN TWO TRACTORS.

AN UNUSUAL ACCIDENT

By A. L. Loy.

THE plant manufacturing the four-wheel-drive tractor shown in the accompanying photo was located quite close to a medium-sized river, which was in the habit of overflowing its banks quite often, and when this occurred it was necessary to move everything possible to a safe distance. In one instance the river came up rather suddenly and it was necessary to run to a safe distance quite a number of these tractors.

The tractor at the right had been run safely up on the side of a small hill and left there, while the operator went for another. In backing up the second tractor, he either became confused, as might be expected in such a case, or else failed to see it entirely. In either case the tractor was coming at full speed, and when the rear driver struck the stationary tractor it simply climbed right up the front end, and when stopped the wheel and, consequently, the greater portion of the weight of that end, was hanging on a five-eighths inch nut on the front end of the frame.

When the collision occurred the operator had presence of mind enough to pull out the clutch before he was thrown off the outfit to the one side. The first tractor was uninjured in any way, although the lugs on the wheel were within a fraction of an inch of the radiator. Practically the only damage done to the moving tractor was the breaking of a ball-and-socket joint over the front axle. The machines steered from both axles as well as having the power applied to all four wheels. The state of the ground through which the tractors had been moved may be judged from the condition of the wheels.

NEW CENTRIFUGAL PUMPING PLANT AT TORONTO RIVERDALE STATION

THE motor driven centrifugal pumping plant recently completed at the Riverdale Station of the Corporation of Toronto is of interest to municipal and other engineers, owing to the great flexibility of speed and capacity of the unit. It was designed to deliver five million imperial gallons in twenty-four hours against a head of 170 ft. and running at a speed of 720 revs. per min., but owing to probable variation in pressure and capacity the city required the unit to deliver either three million gallons or one million gallons against a lower head varying from 130 ft. down to 70 ft.

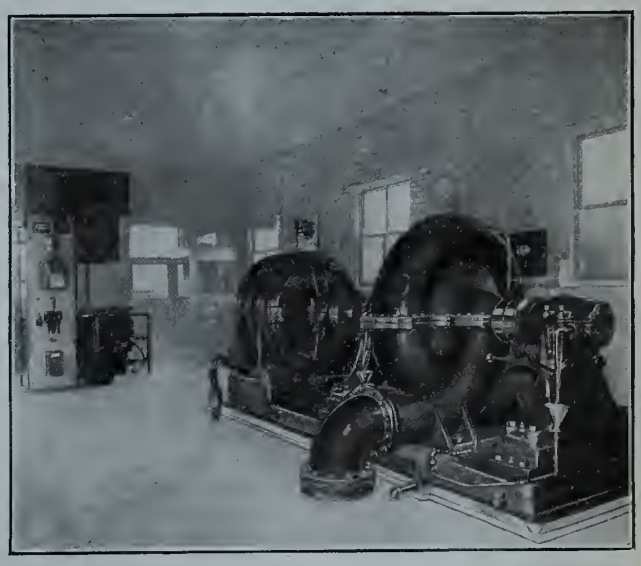
Under such conditions, it is usual to build a multi-stage pump but the contractors, Canadian Allis-Chalmers, Limited, designed and built a single-stage pump which has fulfilled all the guarantees required by the city. The usual practice also is to supply constant speed induction motors for centrifugal pumps; however, as the speed to fill the above requirements must vary from 720 revs. per min. down to 350 revs. per min., the Canadian General Electric Co. built a special 250 horse-power variable speed motor which also fulfills all the requirements.

The pump, which is single-stage with split casing, consists of a cast iron spiral casing with discharge and suction inlet cast on to the lower body. The casing is split on a horizontal centre line, so as to facilitate inspection without dismantling pipe or any other part of the unit. A set of removable diffusion guide vanes has been provided so as to guide the water from the impeller to the casing in the most effective manner. The impeller is made of cast bronze, and polished so as to eliminate unnecessary friction.

Special neck rings have been provided so as to decrease the water leakage from the pressure side to the suction side. The impeller is of double suction type and the head of 170 ft. is generated in a single stage. Proper stuffing boxes are arranged on each side of the extending shaft, and bronze sleeves are provided to eliminate rust and prevent undue wearing. The shaft itself is of hammered steel and of ample stiffness to prevent any vibration.

Separate outboard pedestal bearings are provided in order to carry the shaft, and one of these bearings is arranged with forged collars which act as a thrust bearing to take any unbalanced thrust which might occur occasionally. All bearings are arranged for water cooling, and are of the self-aligning ring oiling type. Separate sub-bases are provided to facilitate dismantling and direction. Both bearings are tied up to the main pump casing by means of stay bolts, so as to make the whole unit as rigid as possible. A flexible pin type coupling is arranged for connecting up this pump with the motor.

The whole unit is set upon a heavy cast iron base-plate which is grouted in to the foundation, and has proven to be exceedingly quiet during operation. An efficiency of well over 70 per cent. has been shown operating under various conditions.



CENTRIFUGAL PUMP WITH CAPACITY OF 5,000,000 IMPERIAL GALLONS IN 24 HOURS.

Big Harbors Needed When War Over.—Improvement in sea transportation was discussed at the London, England, Chamber of Commerce, on Dec. 5, when Lord d'Abernon emphasized the need of bigger ships of great speed after the war. He suggested the government should start the provision of big harbors. About $20,000,000 would provide for vessels of 38-foot draught at practically all the leading harbors from Great Britain to the furthest dominion. The report of the Dominion Royal Commission just issued gives memoranda and tables as to harbors throughout the Empire.

Steam and Its Generation

STEAM POWER DEVELOPMENT*

A SHORT time ago V. H. Manning, Director of the Bureau of Mines, Department of the Interior, Washington, D.C., made the statement that 25 per cent. of the coal production of the United States was wasted through inefficient use. His point was that a large proportion of the steam engine and boiler plants of the country are not up-to-date and are consuming coal wastefully as compared with results given by plants of the latest and most approved design.

Since engineering methods are always advancing, it is out of the question that all of the power plants of the country should be at any one time of the latest design, but Mr. Manning's statement is very suggestive as to the importance to the country of improvements in its power equipment. The annual production of coal in the United States is now about 600,000,000 tons, and 150,000,000 tons of this would be saved if all consuming plants were as good as those of the best type. Perhaps the most impressive idea of this saving can be obtained if the reader will think of the labor involved in mining, handling, and transporting 150,000,000 tons of coal, and of shoveling it into the fire-boxes; and of the benefits that might be derived by having that labor distributed in the other industries.

Generation Back Comparison

If it is interesting to calculate the savings that may be effected in the future by bringing all equipment up to the standard of what at this date is recognized as the best, it is also interesting to compare not only the best practice but the common practice of to-day with the best practice of a generation ago. Mr. Manning's statement has led us to make an inquiry along this line, says a statement issued by the National City Bank, New York, and looking backward for a starting point we fixed upon the Centennial Exhibition at Philadelphia in 1876. Doubtless many of our mature readers will remember viewing, as youths, with awe and wonderment, the great Corliss engine which stood at the centre of Machinery Hall, and furnished the driving power for all the exhibits in the building. There were seats for the public about the engines; the motion of the great flywheels created a breeze, and the engine was the admiration not only of the non-technical public, but of the members of the engineering profession from all over the world.

With the Corliss engine standing out prominently as a landmark in engine development, we appealed to President Alexander C. Humphreys, of Stevens Institute of Technology, for information as to progress in engine-building since that time. It will add a touch of human interest to the story to state that it then developed that Professor Robert M. Anderson, of the Department of Engineering, Stevens Institute, was in part influenced to his choice of a profession by seeing, as a boy, the big Corliss engine in Machinery Hall. By the courtesy of Stevens Institute we have the interesting sketch which follows:

To summarize in the briefest possible manner the progress which it records, the Corliss engine at the Centennial occupied about 54,000 cubic feet of space and consumed 2.2 pounds of coal to develop one horse-power; while a modern steam turbine of equal capacity will occupy 115 cubic feet of space and consume nine-tenths of a pound of coal to develop a horse-power, giving a saving in coal consumption of 59 per cent. According to Mr. Manning's estimate, that the average engine efficiency at the present time is 25 per cent. below the standard of the best type, the average now is well above the best of 1876; and, of course, the average efficiency in 1876 was much below the Corliss standard.

Electric Power Transmission

Even more notable than the improvement in engine and boiler efficiency is the gain accomplished by the development of power transmission through the electric current. The transmission of power by electricity was unknown when the Centennial Exhibition was held, but in the year 1915 51 per cent. of all the power applied to industry in the United States, outside of transportation, was delivered by electric current, and as a result of all this development the total horse-power in use in the United States, to each million inhabitants, was 482,392 in 1915, as compared with 68,182 in 1879, or an increase of more than seven-fold. The facility with which power can be transmitted by electric current does away with the necessity of generating power where it is to be used. It can be generated at the most economical spot, as at the mouth of a coal mine or the site of a water-fall, and the industries which use it may be located in a spot more suitable to them.

High Speed Reciprocating Engines

The introduction of the high speed reciprocating engine dates from shortly after Mr. Edison's invention of the incandescent lamp and development of the direct-current generator in 1881. The isolated lighting plants, followed by small lighting and power plants, gave an impetus to shaft-governed automatic cut-off engines, allowing of higher rotative speeds than were attainable with drop cut-off mechanisms. Among these were: the Buckeye, the Porter-Allen, the Fitchburg, the Armington and Sims, the McIntosh and Seymour, the Ball, the Westinghouse, the Willans, and many others. These were built simple and compound and were operated either non-condensing or condensing. They varied in economy from 3.6 lbs. of coal per hour per B.H.P. for simple non-condensing to 2.15 lbs. of coal per hour per B.H.P. in compound condensing types.

Up to date the highest economy developed in reciprocating engines has been attained in the Stumpf (Straight) or Uniflow engine, obtaining a B.H.P. on 1.08 lbs. of coal per hour, same being in a 300 h.p. engine with an initial steam pressure of 130 lbs. per square inch absolute, and superheat of 261 deg. F. This record has been equalled by the best performances of stationary triple-expansion engines using steam at 170 lbs. per sq. in. absolute and 203 deg. F. superheat. The highest of all steam engine efficiencies so far reached has been obtained by the Wolf tandem-compound "locomobile," which consists of an internally fired through-tube boiler, having the engine combined so that the cylinders are jacketed by the final pass of the hot gases flowing to the stack—in other words, the cylinder projects into the smoke box. The initial steam pressure is from 175 to 225 lbs. per sq. in. absolute, is superheated to 800-850 deg. F. before entering the high pressure cylinder and again superheated to 450-500 deg. F. before entering the low pressure cylinder. The feed water is heated in an economizer in the breeching. The coal consumption of 1 lb. per hour per B.H.P. is common practice and 0.8 lb. per hour per B.H.P. has been attained.

The Steam Turbine

The reaction type of steam turbine, known under his name, was first introduced in England by the Hon. Charles A. Parsons in 1884, and was introduced in the United States by the Westinghouse Co. in 1895, but it was not until about 1900 that it met with general approval. The DeLaval impulse turbine was introduced in its present form in 1889. The compound velocity impulse turbine, known as the Curtis, was introduced into the United States by Charles G. Curtis about 1896.

Since their introduction there have

been many modifications and combinations of these types, better fitting their application to various power developments. For central station work the steam turbine has replaced the reciprocating engine. In fact, the turbine has the advantage in all electric generation, especially in the larger outputs. This is not, however, on account of better fuel economy, since for the same grades of machinery and equal ranges of temperature, pressure, etc., there has been found no appreciable difference in economy betwewen the best turbines and the best reciprocating engines, other characteristics influencing the preference. The real reason for the replacement of the engine by the turbine has been the greater compactness of the latter, thus resulting in a smaller investment in real estate.

Boiler Efficiency

There has been marked improvement in boiler efficiency since 1876. The combined efficiency of furnace and boiler, being the ratio of delivered energy in the steam to that available in the fuel, ranges in coal-fired boilers from about 55 per cent. to 75 per cent. With liquid (oil) fuel and powdered coal, 80 per cent. is attainable. The most remarkable and promising development, the restriction being that the fuel must first be transformed into a gas, is the Bone system of so-called "surface combustion." This consists in burning a perfect mixture of gas and air in boiler tubes filled with porous refractory material, the result being incandescent combination, with no radiation or excess air losses. An efficiency of 94 per cent. has been attained.

Service of Capital

The development of the steam engine illustrates very clearly the part which capital plays in community progress. A steam engine is the servant of the community, no matter who owns it, and the improvements upon the engine, the changing over of power plants to bring them up-to-date, and the construction of new power plants, constantly absorb an enormous amount of new capital. Into such enterprises the profits of business largely go, while the resulting benefits go to the entire community. The man without property, who spends every dollar of his income the same week he receives it, is able to buy more with his wages, because steam engine efficiency has been doubled in the last forty years.

Making Good War Losses

The world is suffering frightful losses through the war, and people are wondering what the effects of these gigantic debts will be upon the earnings of industry and the welfare of the peoples. We may learn something about this from the experience of the past. "It is our improved steam engine," wrote Francis Jeffrey in the "Edinburgh Review" in 1819, "that has fought the battles of Europe, and exalted and sustained, through the late tremendous contest, the political greatness of our land. It is the same great power which enables us now to pay the interest on our debt and to maintain the arduous struggle in which we are still engaged with the skill and enterprise of other countries less oppressed with taxation."

The steam engine which helped England bear the burdens of the wars with Napoleon was a poor affair compared with the engine of to-day, but even the latter, as Mr. Manning and Professor Anderson have indicated, may have its average efficiency in practice greatly increased. Beyond these prospective gains are those which lie in other sources of power, and in all the improvements in industrial equipment which are only partially introduced, or as yet only forming in the minds of inventors. More important than all these are the possibilities which lie in more thoroughly organized and harmonious industry, the development of intelligence and efficiency among the people, and the spread of a better understanding of common interests. We must look to these changes for gains in production which will enable society to overcome the losses of the war, and repeat the progress accomplished by the original application of the steam engine to industry.

THE FIRST HEINE BOILER

AFTER a fire which destroyed the National Guard Armory in St. Louis, Mo., a few months ago, the Heine Safety Boiler Co., of that city, obtained possession of the first Heine boiler ever built, which was installed at the armory in 1881. It has 24 tubes about 10 ft. long; the heating surface is approximately 250 sq. ft., making the rating of the unit 25 h.p. The boiler was built in the shop of Richard Garstang, St. Louis. The original pressure for which it was designed was about 100 lbs. and an inspection certificate from the Fidelity & Casualty Co. has been received to the effect that they will certify this boiler to carry 80 lbs. pressure at the present time.

This indicates a somewhat longer life for water-tube boilers than is usually credited them by accountants or engineers when apportioning depreciation charges. However, under modern conditions the heavier loads on boilers would perhaps tend to lessen their life as compared to this little boiler. One odd feature is the casting which forms both the steam outlet and the water column. Another obsolete feature of this boiler is the vertical baffling which was discarded in later designs for the horizontal baffling, now the standard with Heine boilers of both the land and marine types.

GAS VERSUS STEAM POWER

THE gas engineer changes coal into coke, gas, etc., which afterwards produce heat by combustion. The heat produced by their combustion may be taken as 75 per cent. of the original heat in the coal, but for this efficiency no power whatever is produced. The gas engineer has only changed one source of heat for another source of heat. On the other hand, the steam engineer produces power from the coal; that is, he changes heat into work which is quite a different proposition from merely changing one source of heat into another source of heat.

When the gas engineer has also turned his heat into work he will find that only about 20 per cent. of the heat in the coal has been turned into useful work. The comparison therefore is that a gas engineer producing power from coal will convert about 20 per cent. of the heat of the coal into useful work in a good gas engine, whereas a small steam engine will convert 7½ per cent. of the heat into useful work. Large modern steam turbines are now converting from 16 to 20 per cent. of the heat in the coal into useful work, and thus compare very favorably with gas engines. In addition, steam turbines have been built in single units up to 50,000 kilowatts, are cheaper in first cost and in cost of maintenance, being thus in general more suitable for central power plants.—J. W. Kershaw.

EFFORT TO CONSERVE FUEL SUPPLY

THE U.S. Fuel Administration is making an energetic effort not only to stop the waste of coal but to limit its use as nearly to necessary purposes as the conditions of supply require. A great deal of coal is used for purposes that can be easily dispensed with, even where there is not actual waste.

The official directions sent out to practically all the producers in the East and Middle West require preference to be given to the Government orders, railway fuel, household needs, public utilities, steel plants, coke ovens and munition plants, in that order.

The assumption seems to be that all of these may be adequately supplied if preference can be given to them in deliveries. Their importance is obvious enough, though in the case of household requirements many exceed what is really necessary for health and comfort.

One of the savings proposed is to be effected by the conservation of electric power, which is developed by a large consumption of coal. Among other things it is proposed that railroads which use that power, as most local and short lines do, shall limit their schedules and dispense with extra cars as far as feasible. It is also proposed that they use in cars less heat and light derived from electricity, which is generated by consuming coal. This is likely to be acceptable to operating companies as it will reduce their expense, but it rather comes in conflict with some demands, not only of those using the facilities but of local authorities.

Within that same period of memory not so very long, there was no electric light at all. Now it is squandered on a huge scale in cities, not in a comfortable degree of lighting merely, but in extravagant illumination of many kinds, kept up the greater part of long winter nights.

Electricity and Hydraulics

EXCESS ELECTRIC POWER CONVERTED INTO STEAM

A TYPE of electric steam generator which for some years past has been in use in large numbers in many Italian works is illustrated in Figs. 1 to 5. The apparatus according to "Engineering," to which we are indebted for the illustration, is an invention of Engineer Revel, Colonel in the Italian Army, the manufacturing rights being held by Messrs. Luigi Boselli & Co., Milan.

The principle on which it works is the evaporation of water into steam by means of the heat dissipated in overcoming the resistance of the water to the passage of an electric current. As the flow of current depends on, and varies directly as, the volume of contained water acting as a conducting medium, the control is entirely automatic and demands no attention. Thus lack of feed water would only result in a decrease or stoppage in the production of steam until the supply of water to the boiler was resumed. An efficiency as high as 98 per cent. is characteristic of this type of boiler since the whole of the heat generated by the electrical energy is absorbed by the water, the only loss being that caused by radiation from the body of the apparatus.

Alternating current of from 200 volts to 3,600 volts may be applied, the only difference between the high tension type and the low tension type being a modification in the shape of the electrodes and the dimensions of the steam dome. Fig. 5 illustrates the half of an installation of eight units taking three phase current at 6,000 volts, each apparatus being capable of generating 405 pounds to 450 pounds of steam per hour.

Figs. 1 to 4 illustrate a similar apparatus designed for 500 volts, the arrangement of the component parts being clear from the explanatory notes accompanying the illustration. For starting the generator the circuit-breaker is closed, the valve i is opened, and a small quantity of soda solution is introduced from the small receiver e to give a suitable conductivity to the water. When the water has reached the height of the lower edge of the electrodes the current flows through the water and commences to raise steam, the steam production increasing as the water-level rises, until it reaches the working pressure required. At this moment the regulator f enters into action, and the water-level and hence the steam production remain constant. In order to stop the apparatus the feed-water valve i is closed, the steam valve b is closed slowly, and the drain valve g is opened by acting upon the hand lever h until the ammeter has returned to zero.

When the feed water leaves a calcareous deposit it is advisable, every five or six hours, to free the boiler of the sediment deposited at the bottom of the truncated cone. This is obtained, without interrupting the working of the machine, by increasing the water feed and by acting at the same time on the handle h, the excess water washing away the sediment; this operation, by a suitable action upon the valves i and g, and by following closely the ammeter and maintaining the current intensity constant, is carried out without changing the water-level and without impairing the working of the apparatus.

The Revel generators are constructed to work at any pressure up to 14 atmospheres, and can be connected up at any time with the steam pipes from the ordinary steam boilers; owing to the rapidity of their action they take up any excess of hydro-electric energy which may be available even for a short time. They may, in fact, be considered as serviceable appliances for turning to account any superfluous hydro-electric

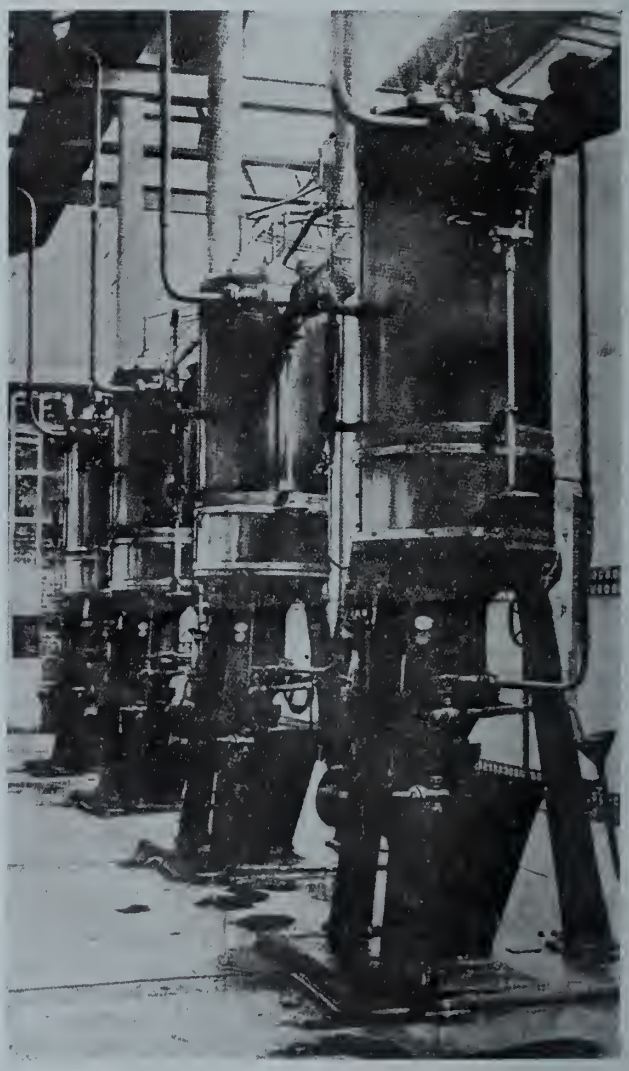


FIG. 5. EXTERIOR VIEW OF BATTERY OF ELECTRIC STEAM GENERATORS

power available, and as such they were utilized in numerous installations in Italy before the war, when the price of coal did not exceed 32s. per ton. At the present time they are also found to be practical and economical, even in cases where hydro-electrical power has to be paid for at the rates now ruling.

ELECTRICAL NOTES

Power Factor of Induction Motor.—Does the power factor of an induction motor change with the load, and how can it be measured? J. S.

Answer.—The power factor of an induction motor is greatest at full load, and decreases on light loads and overloads. Power factor meters are supplied for measuring this factor, but a substitute method may be used when a wattmeter, voltmeter, and ammeter, of the correct capacity and range are available. Connect the wattmeter series coil in one phase of the motor with its potential coil terminals across the phase to measure the watts imput per phase. Also measure the volts and ampere imput for the same phase. Then the power factor is the true power consumed in watts divided by the total power imput in volt $\times$ ampere $=$ w. / v. $\times$ k.w. / k.v.a. J. S.

* * *

Size of Wire.—Can you state what size wire I should use to connect a 7 h.p., 550-volt direct-current motor to the switchboard in the engine room, located about 750 ft. away from the motor? N. McC.

Answer.—The difference in potential at the beginning end end of the circuit you propose to instal, or in other words, the line loss, will govern the size of wire used to carry the load. The allowable line loss for the motor may run as high as 10 per cent., the object being to use the least possible copper consistent with economy and safety. We will assume in this case the line loss to be 5 per cent. and the efficiency of the motor 90 per cent. Then the volts lost in the line will be $\frac{5}{100} \times 550 = 27.5$ volts and the voltage impressed on the motor will be $550 - 27.5 = 522.5$ volts.

The watts taken from the line by the motor are $\frac{\text{H.P.} \times 746}{\%\ \text{Efficiency}} = \frac{7 \times 746 \times 100}{90} = 5{,}800$ watts.

Gives $\frac{5800}{522.5} = 11.1$ amps. taken by motor.

We have then the current flowing in the wire to be 11.1 amperes and the voltage drop in the line to be 27.5 volts. The resistance, then, is given by the formula $C = \frac{E}{R}$ $R = \frac{E}{C}$;

$$\text{Resistance} = \frac{27.5}{11.1} = 2.48 \text{ ohms.}$$

This is for a length of wire $= 750 \times 2 = 1{,}500$ ft., for it is a two-wire circuit.

The wire tables found in any mechanical handbook give the size of wire in B. & S. gauge opposite values of resistance in ohms per 1,000 ft. In this case the resistance in ohms per 1,000 ft. $= \frac{2.48 \times 1000}{1500} = 1.65$ ohms, and comes between the values 1.58 for No. 12 wire and 2.00 for No. 13. The even gauge numbers are most usually used commercially, so choose the next smallest size, No. 14, as being the most economical of copper, if no mechanical strain is placed upon it. If, however, it is to be run out of doors on insulators, the use of No. 12 would be preferable as being mechanically stronger.

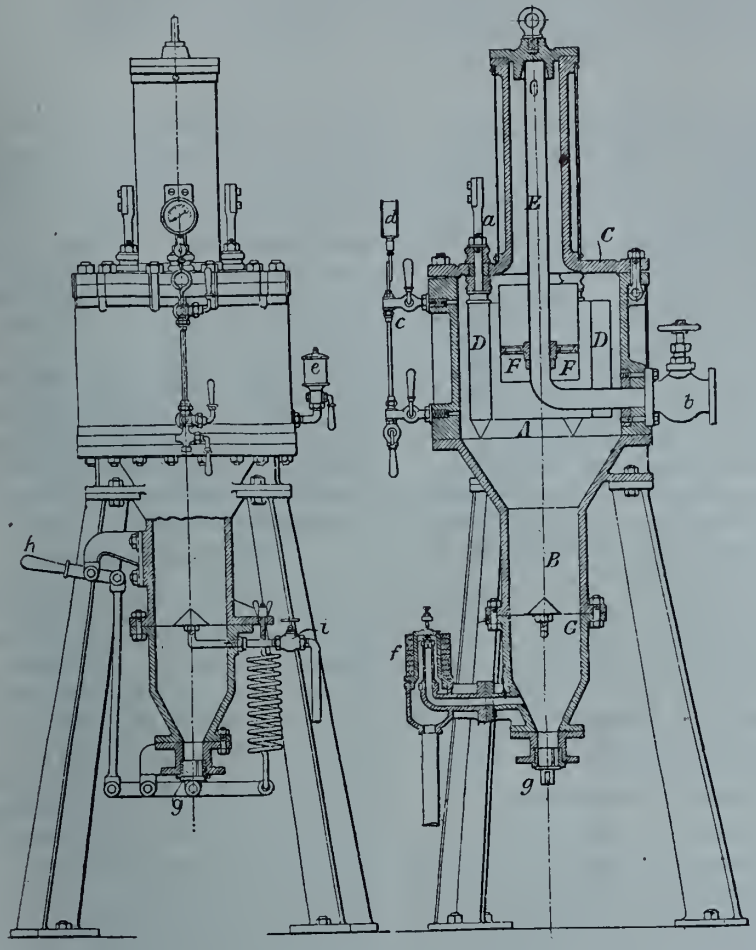


FIG. 1.

FIG. 2.

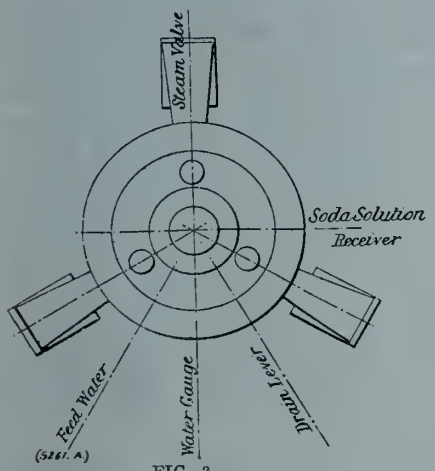


FIG. 3.

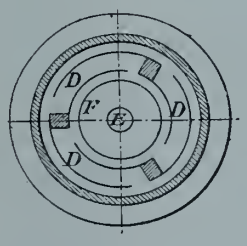


FIG. 4.

A, electrode and steam space; B, cold water space; C, cover (steam dome), through which run three brass rods a electrically insulated from the cover; D, steel electrodes rigidly fixed to the rods, a; E, steam pipe; F, steam pipe support and baffle: G, feed-water injector; b, steam valve; c, water gauge; d, pressure gauge; e, receiver for soda solution; f, water-level regulator, which automatically governs the working of the apparatus; g, safety and drain valve; h, handle for working valve g by hand; i, feed-water valve.

Modern Steam Power Plant and Its Appliances-II.

By John H. Hale*

Despite the wonderful developments of hydro-electric power generation, the modern steam power plant occupies a firmly established position in engineering effort from which its removal, if it take place at all, will never be more than temporary. The economies possible in large plants and the duty of all engineers to adapt such methods to their small individual plants wherever possible is emphasized by the writer.

THE subject of furnace efficiency is one which may be expanded almost indefinitely, and involves a consideration of all the requirements of modern stoking and the inability of the individual to divide his attention and obtain the same result as when his attention is concentrated. In other words, it involves not only the preliminary of machine efficiency, but involves the question of human reliability and human weakness. I desire, therefore, to set forth the relation between furnace efficiency and the usual practice in boiler room management.

Efficiency and Practice

It is a well known fact, and one from which the plant owner continually suffers, that it is extremely difficult to get the same efficiency from a number of units in service simultaneously that may be developed when one unit is under test. The engineer in charge will usually proceed by taking some one unit and fitting it with the necessary pump and measuring apparatus for conducting a boiler trial or test. He will find, perhaps, that his furnace is not developing the efficiency to be expected.

The results of his preliminary run will indicate perhaps too high a percentage of free oxygen in the gases, too large an amount of CO, or too high a temperature of flue gases. The next step will be to remodel the furnace, change the type of grate surface, add to his height of chimney, increase his combustion arches, or in other ways seek to provide more satisfactory conditions for the development of those results which he knows he requires. Herein lies the first test of the engineer's ability, and no one can prescribe more than general rules for the perfecting of his boiler units. A reiteration of the essentials for furnace efficiency need not now be set forth in detail, as they are common property and have been rehearsed so often that they are practically universally known. The exact means, however, that must be used to secure the desired result is an entirely different problem, although if the engineeer has the ability to properly measure and co-ordinate the existing conditions, the remedies are usually comparatively obvious.

The problem of putting into practice the remedies which he knows are necessary is another difficulty. The area designated as head room and floor space is to hold therein the products of combustion until such combustion is complete, and to support the burning fuel in such a manner that it may be burned with the minimum practicable amount of air.

Commercial considerations render it impracticable to provide a furnace theoretically perfect, as the questions of cost and maintenance are quite as important in the final estimate as questions of daily efficiency, and we continually sacrifice efficiency in the furnace to the initial consideration of original cost, maintenance, depreciation, charges, rent, etc., etc. We have, therefore, to consider a certain efficiency as the maximum efficiency that may commercially be obtained, and this is expressed in terms of the furnace substantially as follows:

1. It is not possible to burn bituminous coal with much less than 50 per cent. excess of air, or in the neighborhood of 18 lbs. of air per pound of coal.

2. It is not commercially possible to burn more than 98 per cent. of bituminous coal fed to the furnace.

3. It is not commercially possible to extract so much heat from the escaping gases that their temperature shall be less than the temperature of the steam at the given boiler pressure.

Primary Considerations

These three primary considerations are the ones which should be first taken into account by the engineer in his analysis of furnace efficiency. The exact methods to be employed by him in determining the means for accomplishing the desired results cannot be herein prescribed, as they differ with every design of boiler furnace and grate surface. That different boilers have different heat absorbing powers is unquestioned, and that different grate surfaces have different capabilities of retaining fuel under combustion is also unquestioned; and that there are different capacities for holding the gases of combustion is perhaps the most obvious of all. It should, however, be the aim of the engineer to secure not less than 10 per cent. of CO in flue gases, which may be accomplished by stopping all air leaks around the setting of the grate surface, by keeping a uniform fuel bed without holes or leaks, by carrying a fuel bed of sufficient thickness that extreme porosity is avoided, and by not opening the furnace doors more than the necessary minimum.

If all the air entering the furnace is compelled to pass through the bed of burning coal or fuel in order to enter the furnace, satisfactory results must almost necessarily follow. It is the unauthorized air leaks that do the damage, and these must be eliminated. All the heat carried away in the escaping gases is lost, and it is obvious that this amount must be reduced to a minimum. Economizers will actually economize, provided the resistance to the flow of the gases offered throughout does not cause greater loss by causing decreased efficiency in the furnace and increased waste in the ash pit. Not only must the temperature of the escaping gases be considered, but adequate furnace draught must be attained or you will lose from the one more than you will gain from the other.

As a general rule with bituminous coal satisfactory combustion cannot take place and proceed with less than .25 in. draught in the furnace. This is without reference to boiler capacity, which is a function of the grate area as well as of the draught intensity.

Flue Gas Temperature

Flue gases in temperature cannot be reduced below 425 deg. F., and a working temperature of 500 to 550 deg. F. is usually considered as satisfactory as it is practicable to obtain. Any increase of this temperature may mean either a short-circuiting of the gases in the boiler, due to defective baffles, excessive velocity of gases in the boiler setting, or air leakage at or near the furnace. It may be due also to defective heat absorbing power of the boiler, the result of scale or soot inside or outside of the tubes. It is safe to say, therefore, that any temperature over 500 deg. in the flue should at once cause an investigation that the absorption may be increased and the waste at this point decreased.

With the unit in a satisfactory condition of efficiency, the next problem is to extend this efficiency throughout the boiler room, and operate a number of units in such a manner that the over all results may be, as nearly as possible, equal to the unit results. This is a question which involves the ability of the operator to divide his attention, and is very largely a question of discipline in the boiler room. It frequently happens, that there is 10 per cent. or 15 per cent. less efficiency, when the entire plant is considered, than is shown in a single boiler test, so it becomes very important that the management should establish such routine and system as will offset the negligence, carelessness, or inability of the fireman.

Systematic Analysis

Perhaps the most satisfactory method is the method of continuous test, which is one of original equipment and systematic operation. In this system each furnace is supplied with coal which passes through a weighing tank, so that the exact amount of coal burned in every furnace is made a matter of

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daily record. The entire plant is equipped with recording Venturi meters, and if possible each unit is supplied with an indicating Venturi meter in the auxiliary feed line. Daily records of the recording meter are kept up and by means of the individual indicating meters the water consumption of a particular unit may be checked up at any time. Attached to each boiler is a Hays gas sampling tank, which may be adjusted to withdraw a sample of the flue gases for any period desired. The station is also equipped with the gas analysis instrument by which the engineer may analyse his various gas samples daily, or on each shift. This result should be posted in the boiler-room, with the name of the fireman indicated thereon, and any fireman not developing the required quality of gas is in line for some private instruction. A daily sample of the ash from each boiler is taken and analysed for combustible. This result is also posted in the boiler-room the following day with the number of the boiler and the fireman in charge thereof.

It will be found that competition between various firemen, or various shifts, will be immediately established, and the dome of the entire boiler-room will be removed almost automatically. If it does not have its result, the chief engineer has the information at hand that will enable him to apply the pressure in the right place.

Necessity for System

All of this might seem like an unnecessary expense and an impracticable proposition, but in the plant containing many boilers it is economy of a proper and essential kind. When the waste of heat up the stack and into the pit is measured in dollars and cents, there will be no question as to the saving to be effected by the above procedure, and all that is necessary to convince the skeptic, is to figure what it will cost to do this, and what it would cost not to do it.

The above system supplies the essentials for a continuous test, and the engineer-in-charge can daily check up his operatives, placing the blame for low efficiency exactly where it belongs, and thereby be equipped with the information necessary for the immediate elimination of the waste. As in other matters, eternal vigilance is the price of economy, to paraphrase a well-known author. The descent into efficiency is easy.

Automatic Steam Regulation

The economy of automatic steam regulation in a boiler plant, is of sufficient importance to warrant any manager or superintendent taking the time necessary to investigate it. The prime object of damper regulation is when the steam rises above the required pressure, and a great loss is being sustained by the engine being supplied with steam at higher pressure than it requires to do its work properly and easily, to so handle the feeding of the fuel and regulate the draughts that steam may be supplied to the engine as it may need it, and at constant and unvarying pressure.

It is practically impossible for the firemen to maintain steam at an exact pressure without mechanical aids. The varying load of an engine caused by the throwing on or off of the various machines throughout the plant or the different amount of work which these machines are required to do affects the amount of steam which is used by the engine.

If all the machines are working to the limit of their capacity the engine is taking a great deal more steam to keep them going at the proper speed than if some of them are idle of working light. The fireman has no means of knowing when the load is going to be light or heavy, the best he can do is to keep the steam at about the required pressure.

If the load, or in other words the amount of work which the engine is doing, should increase for a while or be kept at full capacity, the firemen would keep the hot fire under the boiler, in order to generate steam enough to keep the engine turning at its correct speed. Should the work slacken on the machines, which it will do for any one of a number of reasons such as the stopping of a certain set of machines, this action would lighten the load on the engine, causing it to take less steam through the action of the governor; but the fire under the boiler would keep on generating steam at this time, which the engine has no use for.

The result would be that the steam pressure would rise, and the safety valve release the pressure, thus allowing the excess steam to escape into the open air.

Waste Means Loss

This of course is a waste of steam, water, coal, and labor, which means a loss of money to the owner. This may be prevented by a damper regulator, just as an engine is prevented by the governor from running away. The damper regulator acts on the boiler just as the governor, acts on the engine. No one would think of asking the engineer to stand by the controlling valve of his engine in order to regulate the amount of steam it should have to keep it turning at a speed so as to produce the necessary amount of work throughout the factory.

We all know that the machines throughout a plant do their best work while running at a certain speed. Their speed is regulated by the size of pulleys attached to the line shaft. The speed of the line shaft is regulated by the engine. The number of revolutions made by an engine in a given length of time is controlled by the steam supplied to it by the boilers, and regulated to a certain extent by its governor. When the steam drops below the required pressure only a few pounds, the governor will keep the engine turning at the same speed, but it will be by the admission of more steam to the cylinder.

To maintain the engine speed, the steam consumed is increased in two ways, first, by its expansive power as the pressure is reduced. The higher the pressure, the drier the steam will be, causing quicker action and more expansive force, thereby doing more work with a less volume of steam. When the steam is low, the engine takes more of it to do the same work. This means that more water has to be evaporated, that more water has to be pumped into the boiler, which also requires more steam, all of which means that more fuel has to be burned in order to evaporate the extra water required to make the extra steam.

Automatic Damper Operation

If, when the steam is low, the full load is put on the engine by the operation of all machines in a plant, or an extra load on some of them, the machinery throughout the entire plant will drag, and the production of that day will be less than normal.

This condition may be prevented by the automatic damper regulator. When the steam reaches the given pressure it closes the upper or back damper, on the instant; it does not wait until the steam has gone over the mark, nor does it close it before the steam reaches the required pressure. By closing the back damper, the heat arising from the grate is held in the tubes and around the boiler, so that the damper may be shut longer, and the steam pressure remain up longer, without burning more fuel than would be burnt when the fireman closes the ash pit doors, allowing the heat to be free to pass on to the stack.

The latter method is resorted to when no regulation is used. When the upper or stack damper is closed, the air is entirely prevented from passing through the coal. Coal will not burn, unless supplied with air. This leaves the coal lying on the grates, but not burning, ready the instant the damper opens to start generating more steam, thus keeping a more even heat on the boiler and tubes, and preventing the contraction and expansion which causes so many leaky tubes.

When the damper is used the ash pit doors remain open, allowing the air to circulate under the grate bars, which keeps the latter in better shape and makes them last longer than they would if the ash-pit doors were closed, shutting out the air and allowing the intense heat of the furnace to strike down.

Where there are automatic stokers under the boilers, the damper regulator is connected with the stoker engines, as well as with the damper. When the damper closes, the stokers are slowed down so that the supply of fuel is checked until the damper opens again, and more fuel is needed. This is accomplished either by a mechanical connection to a quick opening valve, or by a water connection between the regulator cylinder and a pressure regulator on the stoker engine supply line. When burning gas or oil as fuel, an extra quick opening valve is used on the burner supply pipe, and the regulator opens and closes this valve as well as the damper. This cuts off the supply of gas or oil and insures a positive saving.

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Vol. X. DECEMBER, 1917 No. 12

PRINCIPAL CONTENTS

Plant Equipment and Product—The Goodyear Tire & Rubber Co. 331-340
General 340
The Invention of the Steam Hammer....Man-Power Biggest Factor in Industry....Maintenance of Crane Railways....
More Fuel Oil for Steamers.
Comparison of Working Costs of Principal Prime Movers—II. 341-344
General 344-345
Before and After .... Recent Developments in Potash Production.
Steam and Its Generation 346-347
Steam Power Development.
General 347
The First Heine Boiler....Gas versus Steam Power....
Effort to Conserve Fuel Supply.
Electricity and Hydraulics 348-349
Excess Electric Power Converted into Steam....Electrical Notes.
Modern Steam Power Plant and Its Appliances—II. 350-351
Editorial 352
Victory First, Then —?....With Best Wishes to All.
Association and Personal 353
The Operators' Point of View 354
Does a Piston Stop at Reversal?
Progress in New Equipment 355-357
Selected Market Quotations 358
Trade Gossip, Catalogues (Advtg. Section) 46-48

VICTORY FIRST, THEN—?

TO those who have listened to the appeals and exhortations from workers for the Victory Loan during the past few weeks, who have noted the presence in their midst of men prominent in the industrial world, who have studied the statements and weighed the remarks of those men with more than ordinary care and deliberation, one feature stands out above all other considerations and that is the unredeemable debt which every living soul in this country owes to each man and boy, yes and woman too, who have gone forth at the call of duty, and in many cases fulfilled it to the last.

Business men, manufacturers and others who could have stood back have gone amongst their workers and friends, and by virtue of their very earnestness and sincerity have influenced the indifferent and strengthened the willing to insure to the greatest possible extent the overwhelming success of Canada's Victory Loan.

Apart, however, from the sentiment of the situation and the disastrous effects which would have resulted had failure attended their efforts—a catastrophe which we now know is impossible—one feature which was given considerable prominence and which impressed many hearers hitherto unacquainted with it was the tremendous wealth of the Dominion in natural resources. To fully expound this phase of the country's effort would tax the powers of any student of political economy, but its true perspective at the moment can be faintly realized if one considers for a moment just how much visible wealth there is now in this country, both individual and corporate, and that such wealth, in case of emergency, would become national.

The immense sum represented by this is the result of approximately only half a century's development and is therefore but a fraction of what will be in existence in the next half century, yet all this that we call wealth is but evidence, some of it tangible, some of it intangible, of the value of this part of the North American continent as a habitation for mankind.

While in some respects our country has been blessed through the absence of war's terrors, the fact of such immunity may be ultimately a handicap which will demand increased effort on our part to overcome. The demands of war have been felt most intensely and insistently in Britain and France, and later in the United States. The former countries, however, by reason of their previous dependency on Germany for many essential materials, were called upon to make efforts beyond comprehension at this distance, efforts which have resulted in many industrial developments that ultimately will more than compensate for the present strenuous times.

It is here that we, with our latent potentialities, must be fully alive and awake to the probabilities of the future. Much is said of our enormous water power resources, but when munitions and stores of war vanish from the factories, when nations cry aloud for the necessities of life, when efforts to make the world a place to live in are resumed on an unprecedented scale, shall we be willing and able to apply that wealth which is our present strength to the amelioration of the lot of those of our brethren whose bravery and sacrifice has been our present protection?

It is there that our future duty lies, not scarred with battle and torn with strife, but clothed with humble reward and a due appreciation of our debt to others. While our men and dollars are fighting let not our brains slumber. The race will be to the swift even as the fight is now to the strong.

WITH BEST WISHES TO ALL

THE approaching close of another year is marked by a seriousness in world affairs exceeding any previous occasion, a seriousness which is intensified because its consequences are more freely realized than during similar crises hitherto.

The Festive Season, so strangely sounding in these times, has become, instead an annual period whereby the sufferings of millions are recorded. Joyousness has been replaced by grim determination—happiness is held in abeyance.

To all of our readers we extend heartiest wishes for a Brighter New Year, to those of them sharing in world-wide bereavement we offer our sincere sympathy, and those who have co-operated in making POWER HOUSE valuable and instructive during the past year are assured of both our readers' and our own appreciation of their efforts.

Association and Personal

PERSONAL

L. W. Adam of Bethlehem, Pa., has been appointed to the position of General Superintendent of the Nova Scotia Steel & Coal Co's. plant at Trenton, N.S. Mr. Adam will reside at New Glasgow, N.S.

Lawrence Russel, who for several years has been sales manager of the Armstrong, Whitworth Co. of Canada, Montreal has been appointed assistant general manager of the company.

Herbert Johnston of the sales staff of the Armstrong, Whitworth Co., Montreal, has been appointed city sales manager, to succeed L. Russel, recently appointed assistant general manager.

John Ross, general superintendent of the mill of the Abitibi Power & Paper Co. at Iroquois Falls, Ont., was caught in the transmission and instantly killed recently. Mr. Ross was one of the highest paid paper experts in America and had been employed at the Abitibi about one year. He was forty-two years of age.

Capt. Arthur J. Latornell, B.A.Sc., at one time city engineer of Edmonton, Alta., has died of wounds received in action in France. Capt. Latornell, a Huguenot by descent, was born in Meaford, Ont. After graduating with honors in civil engineering, Capt. Latornell became city engineer of Edmonton, an appointment which he gave up early in 1916 to qualify for an overseas commission.

Henry J. Fuller, president of the Canadian Fairbanks-Morse Co., has been elected president of E. & T. Fairbanks & Co., of St. Johnsbury, Vt. The election of Mr. Fuller to this office will unite more closely the Canadian and American organization. Mr. Fuller is also a director of the Canadian Bank of Commerce, the National Trust Co. and other industrial concerns in the Dominion. Although born in St. Johnsbury, Vt., Mr. Fuller came to Montreal in 1897, two years after completing his education at Worcester Polytechnic Institute, and established a branch of the Fairbanks Co., which later developed into the Canadian Fairbanks-Morse Co., of which he is now the chief executive.

Toronto Lodge C.A.S.E. Social.—The members of the C.A.S.E. Lodge, Toronto, held their annual "Get-Together" social in the Banquet Room, Temple Building, Bay Street, on Wednesday, November 21. Members and wives, numbering about seventy, thoroughly enjoyed the social, which was a great success. The proceedings opened with a concert, the principal numbers including the following: The Oakwood Quartette, G. Cole, Jr., solos; S. Balmfirth, monologue; John Reid, Scotch songs. Mrs. S. Balmfirth played the opening piano solo and accompanied the singers. The mucis was followed by euchre and refreshments.

PHYSICAL CHARACTERISTICS OF SULPHUR DIOXIDE

THE subject of sulphur dioxide was the subject of some remarks by a writer in an English contemporary in the course of which it was pointed out that the cold producing medium is sulphur dioxide. designated as SO_2, and not sulphurous acid, the chemical symbol of which is H_2SO_3. The gas is obtained principally by burning sulphur in air, when theoretically an exact proportion of oxygen is taken up to provide the compound; water vapor or additional oxygen, however, may also be absorbed. If sulphur is strongly heated it melts to a brown fluid mass which readily ignites and burns with a bluish or lilac flame giving off a powerful odor due to evolution of sulphur dioxide. The gas may also be prepared from compounds containing sulphur and from pyrites, i.e., iron sulphide or disulphide, but not satisfactorily. When the SO_2 comes in contact with moisture, sulphurous acid is obtained, which is converted into sulphuric acid (H_2SO_4) by additional oxygen.

Since it is practically impossible when burning sulphur to regulate exactly the supply of air or oxygen, the gas is likely to attract extra oxygen and form SO_3, sulphur trioxide, or sulphuric anhydride. And since it is equally difficult to obtain absolutely dry air a certain proportion of sulphurous acid will occur since sulphur dioxide combines at once with any moisture that is available. Even if an apparently dry gas is obtained, the minutest leaks in the joints of apparatus through which it is conducted admit air and moisture and these gradually form sulphurous acid and sulphuric acid. While the flame of burning sulphur is colored, the gas itself is colorless. It is twice as heavy as air and is very acid.

OPERATOR ORGANIZATIONS

British Columbia Association of Stationary Engineers, Vancouver.—Subordinate Lodges at Vancouver, Victoria, New Westminster, Cumberland, Merritt, and Fernie.

North-West Association of Stationary Engineers, Edmonton, Alta.

Manitoba Association of Stationary Engineers, Winnipeg.

Canadian Association of Stationary Engineers, Hamilton, Ont.—Subordinate Lodges at Montreal, Toronto, Hamilton, Ottawa, Brantford, Guelph, Kitchener, Chatham, Ont.; St. John, N.B.; Owen Sound, London, Stratford, Belleville, Kingston, Sudbury, St. Thomas, North Bay, Port Arthur, Sarnia, and Windsor, Ont. The executive officers of the C.A.S.E. Grand Lodge are as follows:—

Past President—W. G. Forbes, Montreal, Que.
President—R. F. Gofton, Kitchener, Ont.
Vice-President—Wm. Cooke, Belleville, Ont.
Treasurer.—A. W. Heath, Hamilton, Ont.
Conductor—S. Balmfirth, Toronto, Ont.
Doorkeeper—George Moll, London, Ont.
Secretary.—John H. Hale, Hamilton, Ont.

TORONTO LODGE C.A.S.E.

AN interesting and instructive series of addresses of talks have been arranged to be delivered before the members of C.A.S.E. Lodge No. 2, Toronto. The subjects selected are all of live interest to operating engineers, and will form a regular feature of the meetings this winter. Three papers have already been read: "The Development of the Steam Boiler," by S. Balmfirth; "Chimneys and Drafts," by A. M. Wickens; and "Feed Water Treatment," by T. B. Allen, of the Allen Mfg. Co., Toronto. For future papers the dates and speakers have not all been decided upon. One paper will, however, be read by L. O. Smith, of the Power Plant Equipment Co., Toronto, the subject being the "Skinner Uniflow Engine. A paper on "Hot Water Heating" will be submitted by S. Balmfirth, and the chief engineer of the Monarch Supply Co., Toronto, will address the members on the subject of "Steam Heating." Papers will also be read on the following subjects: "Pumps and Injectors," "Steam Engines," "Combustion, Firing and Draft," "Economical Combustion of Coal," and "Ventilation." The paper on the "Skinner" engine is a special talg, and the date is not settled, but the meeting will be open to friends of the members. A discussion will follow the reading of each paper, which will lend additional interest to the proceedings. The lodge meetings are held in the Temple Building, Bay Street, on the second and fourth Wednesday in the month. The next meeting is on Dec. 26.

The Operators' Point of View

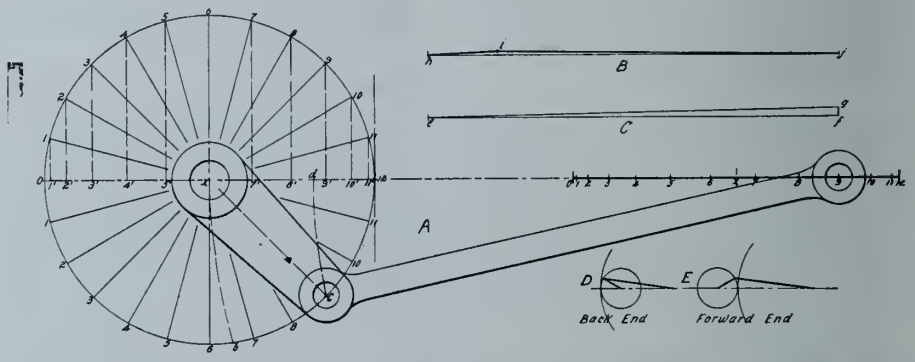
DOES A PISTON STOP AT REVERSAL?

By R. Hamilton

CONSIDERABLE interest has apparently been shown by many readers in the question, does a piston stop at reversal? This is one of those mechanical conundrums that, in itself, has little or no bearing on the actual operation of an engine, but one that will awaken the deepest curiosity in the majority of engineers or mechanics, once they are fairly confronted with the problem. An impromptu reply to this query would invariably be, that the piston does stop at each end of the stroke; but after a little study of the linkage involved, together with the underlying principles of geometry, many are forced to take a neutral stand regarding its proper solution. In the opinion of the writer there are reasonably two answers to the question; that is, theoretically—with absolutely no lost motion in the various connections—the piston does not stop at either end; practically, the piston does make an infinitesimal stop, owing to the fact that it is impossible to make a fit of two moving parts that will be entirely free from lost motion. This looseness, even though imperceptible, is nevertheless present.

On the basis of a theoretical solution, we must realize that if a stop is made it will be when the engine is on either of the dead-centers; that is, when the center of the crank, the center of the crank-pin and the center of the cross-head pin are in the same straight line. We know that this condition exists during each revolution of the crank; so the question now is, how long are these three centers in the same straight line? The geometrical definition of a line is that it has only one dimension, that of length. Therefore, if it has no thickness and the crank is in motion, there can be no stop on the line. The two extreme positions on this line constitutes the points known as the dead-centers of the engine. Again we are faced with the definition that a point indicates position only; it has neither length, breadth or thickness. As the circle described by the crank-pin is not a straight line, it is a logical conclusion that no portion of it is a straight line; so that it is quite obvious that, on the forward stroke the maximum distance between the center of the crank and that of the cross-head is not attained until the dead center is reached, when the action of the cross-head, and other reciprocating parts, is immediately reversed.

A factor that should be thoroughly understood in the study of this problem, is that of the relative motion of the crank and cross-head pins. The uniform motion of the fly-wheel causes the crank-pin to pass through similar circumferential distances in the same period of time. When this rotary motion of the crank is converted—by means of the crank and connecting rod—into the reciprocating movement of the cross-head and piston, the action of the cycles are uniform, but each cycle of the reciprocating parts consists of a gradual accelerating and retarding motion, occurring twice in each revolution of the crank.



ILLUSTRATING REMARKS BY R. HAMILTON WITH REFERENCE TO REVERSAL OF ENGINE PISTON.

By referring to the sketch it will be seen that the crank-pin circle is divided into a certain number of equal parts, illustrating the uniform action of the crank-pin. If the reciprocating motion were obtained by means of a slotted link, the corresponding positions of the cross-head or piston would be indicated by the points on the horizontal diameter derived from the vertical projection of the points on the crank-pin circle. However, with the general practice of using a connecting rod, as here shown, there is a slight variation in the acceleration at either end, due to the angularity of the connecting rod. This is clear from the arcs X-B and C-D. The graduations on the line O-12, to the right, represent the horizontal movement and position of the cross-head for the corresponding positions of the crank-pin.

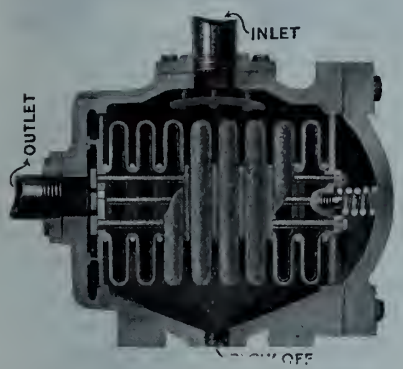
The position of the cross-head can be readily determined when the crank is at any point in its path of travel. By using the length of the connecting rod as a radius and striking an arc from the center of the crank-pin to the horizontal diameter, this intersection will be the relative position of the cross-head between its extreme points of travel. The variation in the retarding or accelerating motion of the reciprocating parts may be better understood by referring to sketches D and E. When the crank-pin is approaching the back end dead-center, the crank and the connecting rod are overlapping, and the arcs that would be described by their outer ends would be tangent in the same direction, whereas on the forward end the opposite action evidently takes place, with the obvious result, that for the same arc traversed by the crank at either end, the speed of the reciprocating parts would be greater at the forward end, as indicated in the lengths O-1 and 11-12 on the graduated cross-head traverse line.

In order to form a triangle we know that the sum of two of the sides must be greater than the length of the third side. With the exception of the "dead-center" positions, this condition always exists in the constantly changing positions of the moving parts under discussion; therefore the solution of the "stop" query may rest on these facts. A skeleton diagram of the linkage approaching the forward "dead-center" is the straight line H-J, the triangle is still shown at B; 1 representing the crank-pin. Until the point 1 coincides with greater than H-J; but, as a line has no existent, and the length H-I-J must be magnitude, the time required for the crank-pin to pass over or through it must be nil—therefore no stop is possible (theoretically). Diagram C is an exaggerated skeleton sketch of the center line of the crank nearing a "dead-center;" E-F-G forms a right triangle, E-G being the hypotenuse, so that the latter must exceed the length E-F until it is in a direct line with it. Some of our readers might advance their arguments as to how long it takes the crank-pin to pass this "line."

Progress in New Equipment

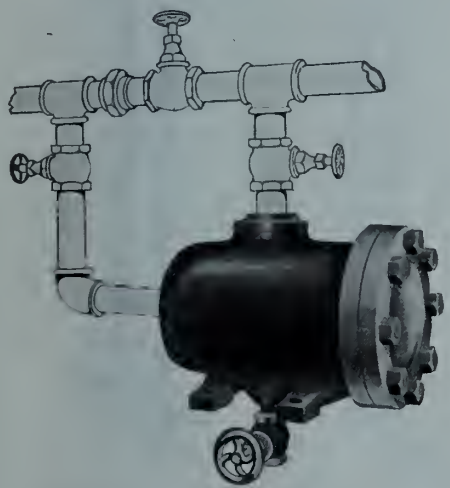
FEED WATER FILTER

THE accompanying illustrations show an interior and exterior view of the Reliance Feed Water Heater, designed, among other things, for the removal of oil from boiler feed water, specially adapted for marine purposes. As seen in the sectional view, the unfiltered



INTERIOR VIEW OF "RELIANCE" FEED WATER FILTER.

water enters at the top and passes into central portion of the chamber, being distributed in all directions by means of the convex disc, which prevents the direct force of influx from striking the fabric material on the outer portion of the cartridge. The cartridges are composed of thin copper perforated discs, covered

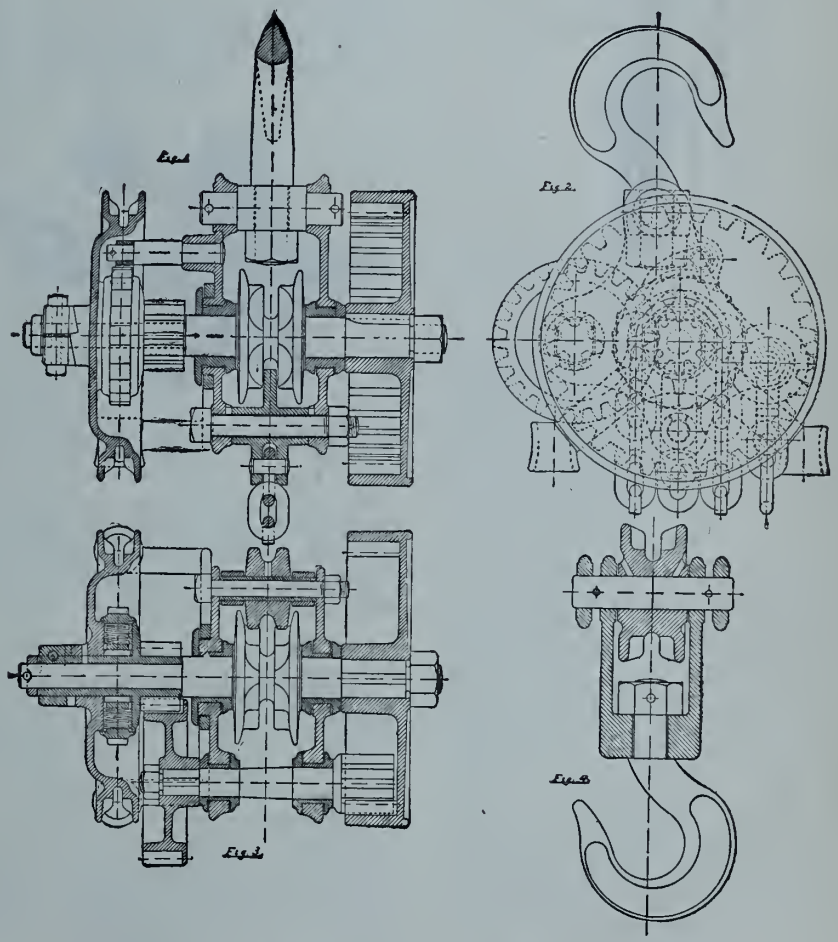


"RELIANCE" FEED WATER FILTER, SHOWING PIPE CONNECTIONS.

with Turkish towelling, through which the water must be forced before it enters the discharge outlet; this causes the oil to be entirely separated and can be blown off at intervals. When installing this filter on the pipe line, it is necessary to provide a by-pass, so that the filter can be cleaned without shutting off the boiler supply. To reduce the "out-of-service" time to the minimum, an extra cartridge is supplied so that the lost time is only that required while the cartridges are being changed. Cleaning can take place while the other cartridge is in service. These filters are manufactured by Darling Bros., of Montreal.

TWO-SPEED CHAIN HOIST

THE accompanying illustrations show the mechanical construction of the Simplex chain hoist, one of a line of hoisting specialties manufactured by J. G. Speidel, Reading, Pa., a novel feature of the apparatus being the simple and ingenious method of securing two speeds.



SECTIONAL VIEWS ILLUSTRATING OPERATION OF TWO-SPEED CHAIN HOIST.

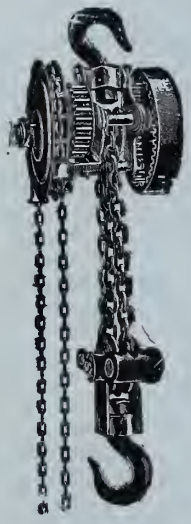
An endless hand chain is laid over the large chain wheel, which, in connection with a pinion and a brake wheel with ratchet teeth in the outer rim, form the automatic brake, which keeps the load from running down. These three parts, when put together, are handled like one piece, and turn loose on the reduced extension of the main shaft.

The pinion attached to the hand chain wheel drives a spur gear, which is keyed to a second shaft, at the end of which is another pinion, which engages with the teeth of an internal spur gear, which is keyed to the opposite end of the main shaft, to which is attached the lift chain wheel. Thus, by means of two pairs of spur gearing, motion is transmitted from the hand chain to the lift chain. By pulling on the hand chain, in one or the other direction, the load is either lifted or lowered.

In hoisting the load the brake wheel, with its ratchet teeth on the outer rim, revolves freely with the hand chain wheel and pinion, not causing any resistance, the ratchet pawl running freely over the teeth. As soon as the pull on the hand chain ceases, the pawl engages with the ratchet teeth on the brake wheel, keeping it from running backward, and so keeping the load suspended.

In lowering the load the hand chain is pulled in the opposite direction, and a slight pull is sufficient to overcome the friction of the automatic brake, thus allowing the load to descend and holding the same suspended again as soon as the operator stops pulling on the hand chain. By a continuous pull on the hand chain the load can be lowered at a good speed.

Features of the design which make for positive action and flexibility of control are as follows: A pawl arrangement in



EXTERIOR VIEW OF TWO-SPEED CHAIN HOIST WITH AUTOMATIC FRICTION BRAKE

the lower block, which locks the hoisting chain to the sheave, allowing light loads to be hoisted at double the speed used when working to capacity load; the guides through which the hand chain passes are closed rings attached to a swinging frame, which permits them to take up the position of least resistance when the chain is pulled at any angle, thus allowing the operator to stand well out from beneath the hoist without imposing undue wear on the chain and guides; the lift chain is prevented from jumping over the sprocket of the lift chain wheel by means of a guide roller, and a stripper, which runs up through the narrow groove of the lift chain wheel prevents the chain from sticking to the wheel.

This hoist is supplied in capacities ranging from 1,000 pounds up to 40,000 pounds, and it is claimed that one man can lift any load up to 16,000 pounds, above which two men are required.

STEAM TURBINE FOR FANS, BLOWERS AND PUMPS

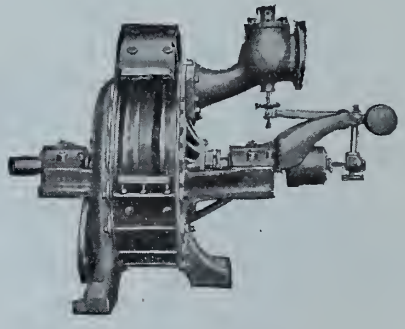
THE Canadian General Electric Company is offering a Curtis Steam Turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems.

It is called the type L and is of the impulse type. The number of stages and rows of buckets vary with the capacity. The principles used and mechanical practice evident in the construction are the result of the vast experience of the manufacturers in producing turbines for practically every class of service.

A split wheel casing is used to permit ready inspection of the buckets which are of bronze securely dovetailed into the rim of the wheel. The exhaust steam is free from oil and is well suited for heating feed water.

Special regulation is close and reliable and the speed may be changed by hand wheel adjustment while the turbine is in operation. A constant running speed is maintained by a simple and powerful speed governor mounted directly on the shaft and controlling a double balanced piston valve type throttle.

The main shaft carrying the turbine and governor runs on babbitted bearings with renewable linings, and is fitted with



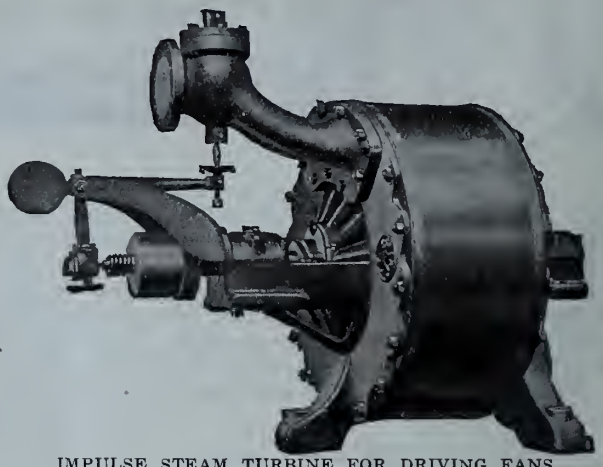
SHOWING SPLIT WHEEL CASING OPENED FOR INSPECTION.

readily accessible packing glands.

Three feet support the rigid frame of the turbine to insure the bearings always being in line. The wheel casing is neatly lagged with planished iron.

THE LONG STEAM TRAP

SIMPLICITY combined with efficiency are the two essentials in the successful operation of any piece of mechanical equipment, and this is increasingly emphasized where there is a possibility of certain parts of the mechanism getting out of order and thereby destroying or seriously affecting its usefulness. Wherever steam is used it is very important to instal traps at certain points to prevent the formation of condensation in the pipe line; both as a feature of effective operation and also as a factor of economy. The accompanying cut illustrates a simple device for freeing steam pipes of condensation, the limited number of its parts minimizing the danger of unsatisfactory operation, through the disarrangement or failure of moveable portions. The operation of this trap is controlled by the expansion and contraction of the thin inner tube, acted upon



IMPULSE STEAM TURBINE FOR DRIVING FANS, BLOWERS AND PUMPS.

by the variation of the steam and water temperatures, the construction being so sensitive as to operate at a variation in temperature of one degree. A feature of the trap is that it can be installed in any position to suit the layout of existing equipment, but where it may be subjected to freezing temperatures it is necessary to instal it in a horizontal

SECTIONAL AND EXTERIOR VIEW OF "LONG" STEAM TRAP WITH OPTIONAL OUTLETS.

draining position, to insure continuous operation. One of the most troublesome conditions of steam distribution is the formation of air in the pipe lines, and the action of the trap here shown as-

SEGMENT OF BOILER GIRTH SEAM PROTECTOR

sures the expulsion of all air and water before the regular operation of the trap commences.

After the installation of one of these traps, the only necessary requirement is that steam be allowed to pass through freely until the entire trap is thoroughly heated, and, when such has been attained, the valve is set with just sufficient pressure to close the opening, so that, as the steam commences to condense, the slight decrease in temperature causes the inner tube to contract and permit the water to escape, and when steam again enters the opening is again closed. This continues regularly and indefinitely. Another advantage is that it will operate against pressure, as it may be desired to force the hot water to a higher level for specific purposes, such as the washing of bottles, etc. The two outlets are an added advantage to the trap, as it may be fitted as a small condenser without destroying its draining qualities. These traps are made in only one size, weighing approximately 5½ lbs., and are capable of draining the equal of from 1,000 to 1,500 feet of one inch pipe. J. T. Long, 84 Adam St., Montreal, is the manufacturer of this device.

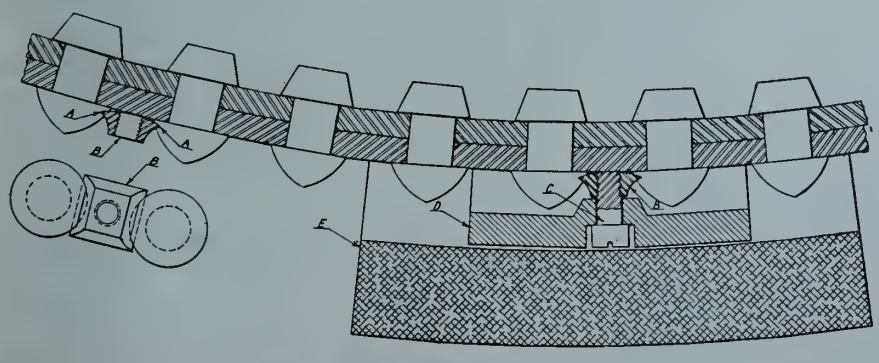
BOILER GIRTH SEAM PROTECTORS

A TROUBLE always resepnt in horizontal tubular boilers is that arising from cracks on the boiler shell surface, directly above the fire chamber. These defects invariably originate at the girth seam, which, owing to the general construction of this type of boiler, is located immediately above the fire, where it is exposed to intense heat. The heat in itself is not the objectionable feature, but owing to the necesity of fire, this portion is subjected to continually varrying stresses, caused by the frequent expansion and contraction of the plates. In an effort to minimize this trouble boilers have been designed where the section exposed to the high temperature of the fires, has been made in one piece, to bring the seam in a position out of the direct action of the hot gases. Owing, however, to the great area required, this method has not given satisfaction, and the seam has still remained more or less a source of trouble and inconvenience.

A simple device for preventing the formation of fire cracks that has been recently perfected, and for which patents have been granted, has been placed on the market, and installed on a large number of boilers, both in the United States and Canada with remarkable results. It is claimed that a boiler equiped with this seam protector will be permanently protected from all danger of fire cracking and subsequent leakage resulting therefrom; an unprotected seam that has developed a leak can be caulked tight and fitted with this device, and the claim is made that the seam will remain dry indefinitely. The illustrations herewith show a general view of the detached show a general view of the detached parts and the method of applying to the boiler shell. It will be seen that the application of this seam protector is very simple and that it does not interfere with the heating qualities or detract from the strength of the seam. As a matter of fact, the construction of the protector, with the large semi-circular sections of fire brick or reinforced asbestos, provides a reserve of heat that prevents any sudden reaction in the seam when the fire door is opened or closed. As the cold outside air from the open door or the hot gases from the fire are not permitted to come in direct contact with the boiler seam, the effect is to retain a uniform temperature on the outer lap, thus avoiding sudden or violent contraction or expansion of the lap.

In addition to preventing exterior fire cracks, it has been demonstrated that the accumulation of sediment along the edge of the inner lap, and about the heads of the rivets—a condition that is generally the cause of interior mud cracks—is largely, if not entirely eliminated, as the retaining of a more uniform temperature at this particular point has shown the tendency to prevent the formation of injuries muddy scale that bakes to this portion of the seam, when the same is exposed to the direct action of the fire. It is thereby claimed that these protectors have made the weakest portion of the boiler equally as strong and durable as any other part.

In fitting this boiler seam protector to units already in service, two adjacent rivets, at suitable distances apart, on the girth seam, are notched by means of a special diamond point chisel as shown at AA to receive the wedge nut B, this being made a snug fit. When same is in position, the metal lug or tile support D is attached by means of a small ½ in. bolt C. When this is firmly placed, the fire brick or asbestos tile E is slid over the extending lugs of the cast iron piece D. Each one of these units is placed approximately 9½ in, apart, and five or more may be required to cover the length of the affected seam. This seam protector is not only used on stationary boilers, but is applicable to all fire exposed seams on locoomotive and marine boilers. These seam protectors are manufactured in Canada by the National Boiler Protector Co. of Canada, 382 St. James Street, Montreal.



SECTIONAL VIEW OF BOILER SEAM PROTECTOR SHOWING METHOD OF ATTACHING TO RIVET-HEADS.

SELECTED MARKET QUOTATIONS

A Record of Prices Current on Raw, Semi-finished, and Finished Materials Entering Into the Manufacture and Operation of Power Plant Equipment

BOILER TUBES

Size	Seamless	Lapwelded
1 in.	$36 00	$.....
1¼ in.	40 00	.....
1½ in.	43 00	36 00
1¾ in.	43 00	36 00
2 in.	50 00	36 00
2¼ in.	53 00	38 00
2½ in.	55 00	42 00
3 in.	64 00	50 00
3¼ in.	.....	58 00
3½ in.	77 00	60 00
4 in.	90 00	75 00

Prices per 100 feet, Montreal and Toronto.

PLATES

	Montreal	Toronto
Plates, ¼ to ½	$13 00	$12 00
Heads	13 30	12 30
Tank plates, 3-16 in.	13 65	12 10

WROUGHT PIPE

Effective July 5, 1917

Black Galvanized

Standard Buttweld

Size	Per 100 feet	
⅛ in.	$ 5 00	$ 6 50
¼ and ⅜ in.	5 12	7 16
½ in.	6 46	8 03
¾ in.	8 17	10 29
1 in.	12 07	15 22
1¼ in.	16 33	20 59
1½ in.	19 53	24 61
2 in.	26 27	33 12
2½ in.	42 12	52 94
3 in.	55 08	69 23
3½ in.	69 92	86 94
4 in.	82 84	103 00
Standard Lapweld		
2 in.	29 23	35 71
2½ in.	43 88	54 11
3 in.	57 38	70 76
3½ in.	71 76	89 70
4 in.	85 02	106 28
4½ in.	96 52	121 29
5 in.	112 50	141 34
6 in.	145 90	183 36
7 in.	190 40	238 00
8L in.	200 00	250 00
8 in.	230 40	288 00
9 in.	276 00	345 00
10L in.	256 00	320 00
10 in.	329 60	412 00

Prices—Ontario, Quebec and Maritime Provinces.

WROUGHT NIPPLES

4" and under, 45%.

4½" and larger, 40%.

4" and under, running thread, 25%.

Standard couplings, 4" and under, 35%.

4½" and larger, 15%.

IRON PIPE FITTINGS

Malleable fittings, class A, 20% on list; class B and C, net list. Cast iron fittings, 25% off list. Malleable bushings, 25 and 7½%; cast bushings, 25%; unions, 45%; plugs, 20% off list. Net prices malleable fittings; Class B black, 24½c lb.; Class C black, 15¾c lb.; galvanized, Class B, 34c lb.; Class C, 24½c lb. F.O.B. Toronto.

COLD ROLLED SHAFTING.

At mill ..... list plus 40%

At warehouse ..... list plus 50%

Discounts off new list. Warehouse price at Montreal and Toronto.

FINISHED IRON AND STEEL

Per lb. to Large Buyers	Cents
Iron bars, base, Toronto	$5 25
Steel bars, base, Toronto	5 50
Steel bars, 2" to 4" base	6 00
Iron bars, base, Montreal	5 25
Steel bars, base, Montreal	5 50
Reinforcing bars, base	5 50
Small shapes	5 75

SHEETS

	Montreal	Toronto
Sheets, Black, No. 28.	$ 9 50	$ 9 00
Sheets, Black, No. 10.	12 00	12 00
Canada plates, dull, 52 sheets	12 00	12 00
Canada plates, all bright	12 50	12 50
Apollo brand, 10¾ oz. galvanized	12 25	12 09
Queen's Head, 28 B.W.G.	11 75	10 75
Fleur-de-Lis, 28 B.W.G.	11 75	10 75
Gorbal's Best, No. 28.	12 00	10 25
Colborne Crown, No. 28	11 25	10 00
Premier, No. 28 U.S.	13 75	9 70
Premier, 10¾ oz.	13 85	10 00

PROOF COIL CHAIN

B

¼ in.	$12 00
5-16 in.	11 50
⅜ in.	11 15
7-16 in.	10 90
½ in.	10 70
9-16 in.	10 70
⅝ in.	10 50
¾ in.	10 40
⅝ in.	10 25
1 in.	10 10
Extra for B.B. Chain	1 20
Extra for B.B.B. Chain	1 80

ELECTRIC WELD COIL CHAIN B.B.

⅛ in.	$15 50
3-16 in.	11 70
¼ in.	8 40
5-16 in.	7 40
⅜ in.	6 35
7-16 in.	6 35
½ in.	6 35
⅝ in.	6 35
¾ in.	6 35

Prices per 100 lbs.

FILES AND RASPS

	Per Cent.
Great Western, American	50
Kearney & Foot, Arcade	50
J. Barton Smith, Eagle	50
McClelland, Globe	50
Whitman & Barnes	50
Black Diamond	37½
Delta Files	37½
Nicholson	37½
Globe	50
Vulcan	50
Disston	50
P.H. and Imperial	50

OILS AND COMPOUNDS

Castor oil, per lb.	50
Royalite, per gal., bulk	16
Palacine	19
Machine oil, per gal.	26½
Black oil, per gal.	13
Cylinder oil, Capital	45½
Cylinder oil, Acme	36½
Standard cutting compound, per lb.	06
Lard oil, per gal.	2 50
Union thread cutting oil antiseptic	88
Acme cutting oil, antiseptic	37½
Imperial quenching oil	39½
Petroleum fuel oil	12½

BELTING—No. 1 OAK TANNED.

Extra heavy, single and double	30-5%
Standard	40%
Cut leather lacing, No. 1	$1 95
Leather in sides	1 75

COAL AND COKE.

Solvay Foundry Coke	.....	.....
Connelsville Foundry Coke	...	.....
Steam Lump Coal	.....	.....
Best Slack	.....	.....

Net ton f.o.b. Toronto.

BOLTS, NUTS AND SCREWS

	Per Cent.
Coach and lag screws	25
Stove bolts	55
Plate washers.....list plus	20
Machine bolts, 7-16 and over	net
Machine bolts, ⅜ and less	10
Blank bolts	net
Bolt ends	net
Machine screws, fl. and rd. hd., steel	27½
Machine screws, o. and fil. hd., steel	10
Machine screws, fl. and rd. hd., brass .....add	20
Machine screws, o. and fil. hd., brass .....add	25
Nuts, square blank .....add	$1 50
Nuts, square, tapped.....add	1 75
Nuts, hex. blank .....add	1 75
Nuts, hex. tapped .....add	2 00
Copper rivets and burrs, list plus	30
Burrs only list plus	50
Iron rivets and burrs	15
Boiler rivets, base ¾" and larger $8	50
Structural rivets, as above	8 40
Wood screws, flat, bright	72½
Wood screws, O. & R., bright	67½
Wood screws, flat, brass	37½
Wood screws, O. & R., brass	32½
Wood screws, flat, bronze	27½
Wood screws, O. & R., bronze	25

MISCELLANEOUS.

Solder, strictly $0	36
Solder, guaranteed	38½
Babbitt metals .....18 to	70
Soldering coppers, 3 to 6 lbs. 0	64
Putty, 100-lb. drums	4 55
White lead, pure, cwt.....16	55
Red dry lead, 100-lb kegs, per cwt. 15	50
Glue, English 0	35
Gasoline, per gal., bulk 0	31½
Benzine, per gal., bulk 0	30½
Pure turpentine, single bbls., gal. 0	77
Linseed oil, raw, single bbls. 1	42
Linseed oil, boiled, single bbls. 1	45
Lead wool, per lb. 0	15
Plumbers' oakum, per cwt. 9	00
Sandpaper, B. & A....list plus	20
Emery Cloth.....list plus	20
Sal Soda 0	03½
Sulphur, rolls 0	05
Sulphur, commercial 0	04½
Rosin "D," per lb. 0	03
Rosin "G," per lb. 0	03½
Borax crystal and granula. 0	13
Wood alcohol, per gallon 1	80
Whiting, plain, per 100 lbs. 2	20

COPPER PRODUCTS

	Montreal	Toronto
Bars, ½ to 2 in.	$55 00	$48 00
Plain sheets, base 16 oz. and heavier	56 00	48 00
Copper sheet, tinned, 14x60 in., 14 oz.	60 00	60 00
Copper sheet, planished, base 16 oz. and heavier	64 00	49 00
Braziers' in. sheets, 6x4 base	55 00	48 00
Tubing T.P.S., base ¾ in. up to 3 in.	60 00	60 00

Above prices are full sheets and bars. Cut sheets and bars are 5c per lb. higher.

BRASS PRODUCTS.

Brass rods, base ½" to 1" rd.	$0 43
Sheets 24 oz. and heavier base	0 48
Brass tubing, seamless	0 55
Tubin, I.P.S., 1" base	0 55

POLISHED DRILL ROD.

Discount off list, Montreal and Toronto ..... Net

RUBBER BELTING

Standard	40%
Best grades	20%

WASTE

White Cents per lb	
XXX Extra	20
Peerless	20
Grand	19
Superior	19
X L C R	18
Atlas	18
X Empire	18
Ideal	17
X press	16

COLORED

Lion	14½
Standard	13
No. 1	13
Popular	11¾
Keen.	10½

WOOL PACKING

Arrow	25
Axle	20
Anvil	15
Anchor	11

WASHED WIPERS.

Select White	12
Mixed colored	10
Dark colored	09

This list subject to trade discount for quantity

MILLED PRODUCTS

	Per Cent.
Set screws	25
Sq. & Hex., Head Cap Screws	20
Rd. & Fil Head Cap Screws	Net
Flat & But. Hd. Cap Screws plus	Net
Fin. & Semi-fin. nuts up to 1 in.	25
Fin. and semi-fin. nuts, over 1 in., up to 1½ in.	20
Fin. and semi-fin. nuts, over 1½ in., up to 2 in., list plus	10
Studs	20
Taper pins	40
Coupling bolts, pins	10
Planer head bolts, without fillets .....list plus	10
Planer head bolts, with fillet list plus 10 and	10
Planer head bolt nuts, same as finished nuts.	
Planer bolt washers	net
Hollow set screws..list plus	20
Collar screws...list plus	30, 10
Thumb screws	20
Thumb nuts	65
Patch bolts .....add	40, 10
Cold pressed nuts to 1½ in. ..... add	$4 50
Cold pressed nuts over 1½ in. .....add	$7 00

METALS

	Montreal	Toronto
Lake copper	$31 00	$32 00
Electro copper	31 00	32 00
Castings, copper	30 00	31 00
Tin	63 00	63 00
Spelter	10 50	10 50
Lead	11 00	10 75
Antimony	18 00	19 00
Aluminum	65 00	62 00

Prices per 100 lbs.

ROPES AND PACKING

Packing, square braided	0 34
Packing, No. 1 Italian	0 40
Packing, No. 2 Italian	0 32
Pure Manila rope	0 39
Transmission rope, Manila	0 45
Drilling cables, Manila	0 41

LEAD SHEETS

	Montreal	Toronto
Sheets, 3 lbs. sq. ft. lb. .....$	12 00	$13 25
Sheets, 3½ lbs.	12 00	13 25
Sheets, 4 to 6 lbs.	13 00	12 50

Cut sheets, ¾c per lb. extra.

Cuts sheets to size, 1c per lb. extra.

A CONTRAST

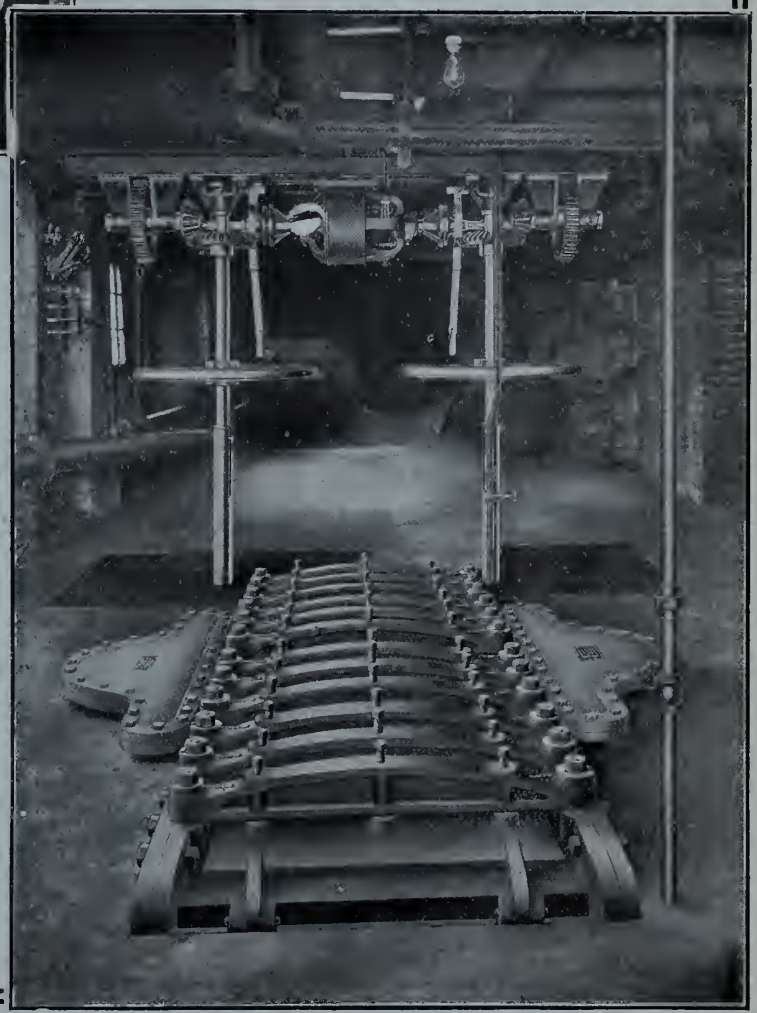
The photograph opposite shows one way of keeping such debris as sticks, leaves, etc., from being drawn into your pumps, condensers and other apparatus.

A diver is engaged periodically to go down under the water to remove the debris that accumulates around the strainer on the inlet of the intake pipe.

The photograph below shows another way of keeping debris from entering your plant via the water intake plan.

A Twin Strainer is used to catch all solids, such as fish, sticks, leaves, twigs, stones, etc., that are carried along in the water. These solids are retained in the baskets of the Strainer, where they can be readily removed at any time without interrupting the flow of water, for when the water is flowing through one set of baskets the other set is out of service.

Motor operated Twin Strainer in 42-inch suction line to condenser—Toledo Railways & Light Company. The motor and operating apparatus is overhead, where it will not be damaged during high water seasons.



Some of the many advantages of the Twin Strainer installation will be readily apparent.

The most obvious one is the convenience of cleaning, which is an assurance against interruptions to the service. The Twin Strainer can be cleaned once or forty times a day, as conditions demand. It can be located in any convenient place inside the plant, where it is accessible at all times.

Twin Strainers will strain water, oil, or any other liquid, and are furnished for either motor or manual operation, in all sizes from 1 to 48 inches inclusive. The basket equipment is varied to suit conditions. Complete information in Bulletin "A." A copy is yours on request.

Elliott Company

6902 Susquehanna St., Pittsburgh, Pa.

This Trap can be installed in any positiondesired as it has two outlets

This is a remark very often made by users in reference to—

The

LONG Patent Steam Trap

Has But One Movable Part

Valve is actuated by the expanding and contracting of a tube, a motion that is positive and of sufficient force to close the valve against a pressure of two hundred pounds.

The Long Trap is automatic and requires no valves except those which control admission of steam to apparatus to which trap is attached. It is capable of draining from 900 to 1,500 feet of one-inch pipe. There are other superior points about the Long Steam Trap, as it could be used as a condenser for heating water for washing bottles, etc., and still remain a trap. Let us tell you the complete story of this wonderfully successful power house facility.

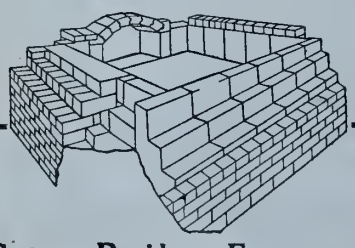
Write.

J. T. LONG

84 Adam Street

MONTREAL, - CANADA

If your dealer does not sell it, write direct.



Gates Boiler Furnace

Patented 1916

Will last three times as long as ordinary good grade Fire Brick. These blocks are inter-locking, and made so that any handy man or fireman can renew them without disturbing any of the other brick work.

WRITE FOR PARTICULARS

John W. Gates 2 St. James St., MONTREAL, QUE.

Trade Gossip

Thorold, Ont.—A hydro-electric by-law will be submitted to the ratepayers.

Winnipeg, Man.—The Prest-O-Lite Co. will build a factory at St. Boniface, to cost $10,000.

Lumsden, Sask.—The Town Council will appropriate $7,000 to acquire the plant and equipment of the local electric light and power company.

Whitby, Ont.—The by-law granting a loan of $25,000 to the United Rubber Mfg. & Reclaiming was passed by the ratepayers by a large majority.

Oshawa, Ont.—A shoe factory may be established here if satisfactory arrangements can be made with the council by the company interested in the project.

Aikenhead Hardware, Ltd., are now distributors for Canada of the Simplex two-speed chain hoists manufactured by J. G. Speidel, Reading, Pa.

Sault Ste. Marie, Ont.—Fire on Dec. 3 of unknown origin caused a loss of several thousand dollars to the Standard Chemical Co. plant. The loss in the latter fire was $7,000.

Orangeville, Ont.—It is reported that the local cement plant, which has been idle for four years, has been sold to a Kingston concern who propose manufacturing a fertilizer.

Toronto, Ont. — The Massey-Harris Co. have taken out a permit to build a dry kiln on the west side of Shaw street, near Strachan avenue and King street, to cost $5,000.

Chatham, Ont.—The T. H. Taylor Co. is in the market for a complete outfit of Jones under feed stokers, and for two boiler installations, including engines and fans, etc.

Toronto, Ont.—A building permit has been issued by the City Architect to the Liquid Air Society to erect a one storey tile and steel addition to their factory at 18 Boler street. The cost will be $2,600.

Galt, Ont. — The City Council have passed two by-laws, one to pay $45,000 on extensions to the hydro-electric system and another to extend the waterworks system at a cost of $18,558.

Toronto, Ont.—City Architect Pearse has granted a building permit to the Bank of Hamilton to erect a three-storey brick bank building at 341 Yonge street at a cost of $4,000.

Toronto, Ont.—Permission has been granted the T. Eaton Co. to erect a one-storey brick delivery building, to cost $45,000, at the corner of Coxwell avenue and the G.T.R. right of way. Building operations have already been commenced.

Japan Needs Steel Plates.—Japan cannot continue much longer to aid the Entente Allies with shipping unless permitted to import steel plates from the United States, Baron Megata, head of the special Japanese finance commission, said at a dinner given by Japanese bankeds in New York recently.

Firm Changes Back to Old Name.—The directors of the International Engineering Works, Ltd., Amherst, N.S., have decided to change the name of the concern to Robb Engineering Works, the former title. A meeting of shareholders will be held in Montreal on Dec. 19 to confirm this arrangement.

The Dominion Bridge Co., Montreal, have obtained a controlling interest in the International Engineering Co., Amherst, N.S., and will carry on the business as a subsidiary. It is understood that the Dominion Bridge Co. have secured contracts for steam turbines and boilers in connection with the marine end of the business.

Sherbrooke, Que.—The city attorney has been instructed to prepare a by-law authorizing the city to issue debentures to the amount of $150,000. This sum is made up as follows: New power dam, accessories, generators and turbines, on Frontenac street, $116,000; turbines, transformers, regulators, tools and apparatus at Rock Forest power station, $34,000.

Montreal, Que.—At the annual meeting of the Mechanics' Institute held at Montreal recently, it was decided to begin the erection of the new building on the site purchased on the corner of Atwater avenue and Tupper streets, next spring. The building will include a reading room, library, lecture room, class or club rooms and a smoking room. The bulding, fully equipped, will cost in the neighborhood of $100,000.

Toronto, Ont.—Works Commissioner Harris has recommended that the Board of Control instal air chambers at the main waterworks pumping station. He explained that the air chambers were needed to safeguard the works from damage to the machinery in case of any temporary suspension of the Hydro service which might occur. Commissioner Harris estimated that the work would cost about $50,000. He was authorized to receive tenders for the work.

U.S. Price-Fixing Power.—Early enactment of legislation extending the United States Government's price-fixing power is expected by administration officials to follow President Wilson's declaration in his message to Congress that authority in this respect is now too limited. The feeling has been growing here that more power is needed to keep down rising prices; and industry, speaking through the Chamber of Commerce of the United States, has declared for the widest possible powers for the Government in this respect.

Dominion Resources Directory.—The first comprehensive and authoritative directory of Canada's natural resources is to be published without delay by the Commission of Conservation. Sir Clifford Sifton, the chairman, gave the first intimation of this at the annual meeting of the Commission last week. Inventories of the various sections of the country will be arranged, and published geographically, provinces having similar resources being grouped together. One

division, for instance, will cover the Maritime Provinces, another the Prairie Provinces, another Ontario, etc. The information to be published, it is believed, will be of the utmost importance in the solution of after the war problems.

The International Business Machines Co. has been launched with a capital of $2,000,000. The new concern will take over the plants and stocks of the International Time Recording Co. and the Computing Scale Co., both Toronto concerns, and the Canadian Tabulating Machine Co., of Montreal. The operations of this latter concern will be at once transferred to this city. By bringing these three companies together a great saving in the cost of management and operation will be effected. Thomas J. Watson will be the president of the new combination, and F. E. Mutton the vice-president and general manager. J. S. Ogsbury is the secretary. L. A. Davidson has been appointed sales manager for the scales division and St. George Bond, of Montreal, will have charge of the tabulating section. The company has $100,000 in cash available for immediate expansion.

Grecian Magnesite Exports in 1916.—Magnesite exports of all grades from Greece in 1916 are given as 176,383 tons. Of raw magnesite the United Kingdom took 60,511 tons; the United States, 56,504 tons; France, 24,607 tons; Italy, 3,100 tons; the Netherlands, 320 tons. Of the caustic and calcined mineral the United Kingdom took 13,127 tons, the United States 9,514 tons, and the Netherlands 730 tons. Of the dead burned grade, the United Kingdom took 3,975 tons and France 3,462 tons.

Lake Superior Ore Shipments.—A record for the month of November in the movement of ore from the Lake Superior district was established last month, when the cargo carriers on the lakes loaded 7,331,804 tons, according to figures just issued. This is an increase over November, a year ago, of 1,616,351 tons, and brings the season's total to December 1, up to slightly more than 61,500,000 tons. The season's total, however, is approximately 2,000,000 tons less than for the same period last year.

Coal Shipments on Lake Superior.—The up-lake coal movement to December 1, was 25,855,737 tons, or 1,938,675 tons greater than for the corresponding 1916 period. Coal movements have virtually ceased, but the year's total likely will exceed 26,000,000 tons. Abnormally heavy uplake coal movement offers a partial explanation for the shortage which prevailed in eastern Ohio and western Pennsylvania industrial districts for months past, greatly crippling operations and reducing the iron and steel output. Coal movement virtually stopped on Dec. 1.

Forest Survey in Ontario.—The Commission of Conservation hopes soon to undertake a survey of the forest resources of Ontario, similar to the investigations it has already made in British Columbia and Saskatchewan. Only

CLASSIFIED ADVERTISING

RATES.

Two cents per word for first insertion. One cent per word for subsequent insertions. Count five words when box number is required. Each figure counts as one word.

CONSULTING ENGINEER

WITH 25 YEARS' EXPERIENCE IN THE following lines: Steam, mechanical, electrical, heating, ventilating and printing. Consultation, supervision and inspection. Fred J. Grant, 126 Denison Ave., Toronto. Phone College 210. p1h

SECOND-HAND ONE HUNDRED (100) horse-power locomotive boiler, and one seventy-five (75) horse-power Corliss engine. Both in first-class condition. Located at Atikokan, Ontario. Address Wm. M. O'Connell, 601 Merchants National Bank Building, St. Paul, Minnesota. (p2h)

FOR SALE

One 22" x 50" Wheelock Engine, left-hand, arranged for direct shaft coupling, with heavy balance wheel 8¼" x 14" x 17'—7" in dia.

Merchants Rubber Factory
KITCHENER, ONTARIO
p1h

JUST LOOK THERE—

The steam user just as well might dump coal into a sewer manhole as go to the trouble of firing up his boiler and then waste the steam by exhausting it in the draw. Don't waste. Use the COLE COAL SAVER — the Cole Return Trap.

Look for this

Trade Mark

GEO. W. COLE, LIMITED
New Address: 2002 Dundas St. W.
Old Address: 838 Dundas St.
TORONTO

When writing to advertisers kindly mention this paper.

Trap Every Steam Line with a SARCO

High Cost of Steam

versus

Low Cost of Trapping

There was a time when steam was cheap. Not now. Now it costs more than at any time within a hundred years.

There was a time when all steam traps were expensive, big, cumbersome, troublesome things.

Not now. Now you can use the Steam Trap SARCO, which is small, low-priced, absolutely efficient and reliable, and goes right on any line anywhere.

Many untrapped lines steal the cost of a Sarco every week.

The Steam Trap SARCO relies on the expansion of a heavy hydrocarbon oil operating a Sarco Spiral Tube with a renewable cartridge. When steam reaches the cartridge, the trap closes and no steam escapes. When condensation collects the trap opens and discharges it.

Write for Bulletin J—2.

SARCO COMPANY, Inc.
Woolworth Building, New York City
Drexel Bldg., Philadelphia
New Telegraph Bldg., Detroit
Monadnock Block, Chicago
Canada: Peacock Brothers, Montreal

NON-CORROSIVE
CYLINDER OIL
MANUFACTURED ONLY BY
E. H. KELLOGG & CO.
NOS. 242 & 244 SOUTH ST. NEW YORK, U.S.A.
FRICTION LOSS

An overload is often a necessity. But it is hard on an engine. To successfully carry an overload so that there will be no after effects on the engine a very careful selection of your oil should be made. An oil that is not free from impurities will cause a greater wearing on the bearings, a great friction loss will occur. You will need to fire the boiler more often because the engine will be harder to run. In this manner you lose out. You work harder, have larger operating costs, and less power all because of your oil. Do as a great many Canadian engineers have done — give Kellogg's "Non-Corrosive Cylinder Oil" a trial. Absolutely pure. Write us regarding it.

E. H. KELLOG & CO.,
New York, U.S.A.

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Sherbrooke Quebec

Engineers, Manufacturers and Erectors of Steel Structures

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Bridges, Buildings, Towers, Tanks, Penstocks, Roof Trusses, Columns, Smoke Flues and Stacks, Coal Bins, Ore Bins, Buckets, Refuse Burners, Stills, Air Receivers, etc.

WRITE FOR PRICES.

MacKINNON STEEL CO.

the most fragmentary data respecting the forests of Ontario are now available, although there is a vast amount of detailed information in the possession of timber owners, Government officers and railways, which could probably be secured. The commission is handicapped in undertaking such an investigation by the scarcity of competent foresters. Last year at the height of the fire season its staff consisted of about 1,000 men.

Shortage of Hydro Power.—The increasing shortage of hydro power has prompted the Hydro-Electric Commission of Ontario to develop an additional 45,000 h.p. at the Ontario Power Co's. plant at Niagara Falls. It is expected that this will relieve the situation until the Chippewa Creek development is in operation. The Chippewa development will furnish 300,000 horse-power and will cost something in the neighborhood of $23,000,000. The Western Ontario natural gas, which has been providing the motor power for many important industries, is falling down, and unless these people can get Hydro power several flour mills will have to suspend operation. Several companies are appealing to the Hydro to help them out now that they can't get natural gas.

Entertained Employees. — The employees of the Hall Engineering Works, Montreal, were recently given a dinner by the directors of the concern at Cooper's restaurant, there being about one hundred persons present. Toasts were given and a musical programme provided. A toast to the employees was proposed by T. Fisher, and responded to by W. F. Fletcher, director, and Wm. Forbes. In the course of the remarks it was evident that a fine spirit existed between employers and employees. A toast to the army, navy and mercantile marine was proposed by W. S. Johnson, and responded to by Lt. Matthews and Capt. Reed. Other toasts were "Our Guests," proposed by Thomas Hall, president of the company, and responded to by Thomas Arnold, and "Our President," proposed by F. H. Fox, secretary-treasurer.

CATALOGUES

Cochrane Precision Meter.—Engineering Bulletin No. 21 deals with the Cochrane precision meter, volumetric type, made by the Harrison Safety Boiler Works, Philadelphia, Pa. A comprehensive description is given of the meter while reference is made to installations on United States battleships. Copies may be obtained on application from Canadian Allis-Chalmers, Ltd., Toronto, agents for Canada.

Industrial Motors.—The second of a series of catalogues of industrial motors has just been distributed by the Westinghouse Electric & Mfg. Co. of East Pittsburgh, Pa. This is known as catalogue 30 and covers the company's complete line of direct current motors and generators for industrial service. After several pages giving general information regarding the ordering, classification and selection of direct current motors there follows complete description, rating and dimensions for type SK commutating-pole motors, various modifications of type SK elevator motors, reversing planer motor equipment, type CD motors, headstock equipment for woodworking plants, type SK and CD motor generators and arc welding equipment. Much new information is given especially on such subjects as arc welding, headstock equipment, motion picture service and battery charging service. The new catalogue is identical in size and will fit the binder for the company's line of catalogues covering supply apparatus and small motors.

CYLINDER LUBRICATION

A powerful microscope will disclose hundreds of irregularities on a bearing surface, no matter how smooth it may appear to the naked eye.

DIXON'S Ticonderoga Flake Graphite

will fill up these minute irregularities and form a smooth, durable veneer of graphite that is practically frictionless.

It will give better lubrication, cut the oil bills in half and eliminate wear and tear.

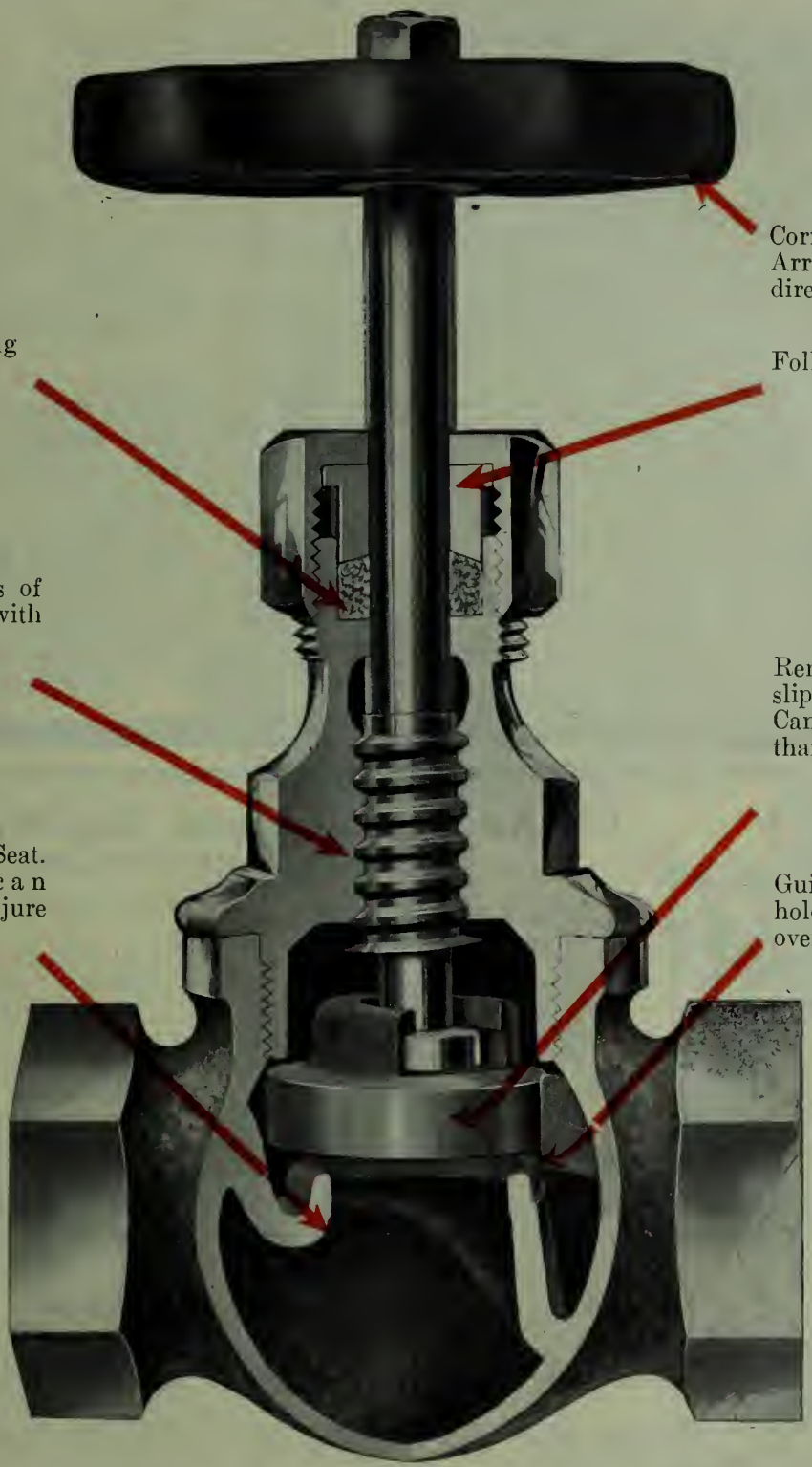
Send for Booklet No. 222-C telling more about this lubricant and method of successfully feeding dry graphite into cylinders

JOSEPH DIXON CRUCIBLE COMPANY
ESTABLISHED 1827
Sole Canadian Representative:
CANADIAN ASBESTOS CO.
Montreal, Que.

MONCRIEFF'S "UNIFIC" WATER GAUGE GLASSES
Stand in a Class by Themselves for Quality, Efficiency and Economy
A trial will convince you. Write for Catalog
W. J. WALL, 134-136 BLEURY ST., MONTREAL
(Canadian Representative)

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

Fairbanks Valves



Corrugated Iron Wheel. Arrow cast on wheel shows direction Valve opens.

Palmetto Twist Packing

Follower in Stuffing Box.

At least Four threads of Spindle engaged with Bonnet at all times.

Renewable Bakelite Disc slips over end of spindle. Can be replaced in less than one minute.

Raised round Seat. No sediment can lodge on it or injure Disc.

Guides Cast on Body hold Disc centrally over seat.

These valves ready for delivery after the first of the year.

The Canadian Fairbanks-Morse Company, Limited

St. John Quebec Montreal Ottawa Toronto Hamilton Windsor Winnipeg
Saskatoon Calgary Vancouver Victoria

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

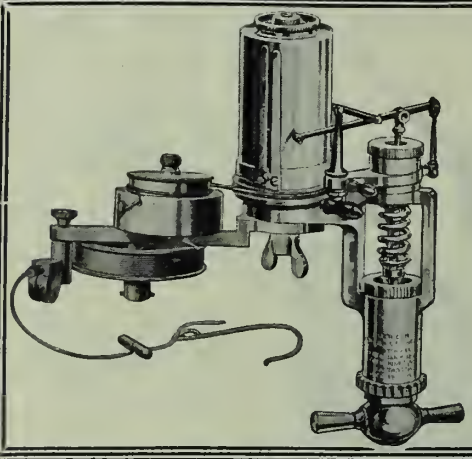
DURABLA

No defects in manufacture pass these men, who inspect every sheet.

The Durabla sheet is a quality sheet, and we guarantee every gasket cut from it to make a permanently tight joint.

Only quality promotes Efficiency. Only standardizing on the best proves true economy.

Durabla Mfg. Co.
NEW YORK
Distributors for Canada:
The Canadian Fairbanks-Morse Co., Limited



The American-Thompson Improved Indicator
HAS MANY FRIENDS.

One Engineer writes:

"I am well satisfied with the instrument and would not take what I have paid for it if I could not get another. I want to tell you what I have done since I have gotten the outfit—the coal consumption before ran as high as 22 pounds per K.W., and I have, by the use of the Indicator, brought it down as low as 10 pounds per K.W. I discovered leaks in the engines that opened the Company's eyes and got them busy."

This Engineer's name and address will be cheerfully furnished on request.

Canadian Agents: The CANADIAN FAIRBANKS-MORSE COMPANY, LTD., Montreal, Toronto, St. John, Winnipeg, Quebec, Calgary.

AMERICAN STEAM GAUGE & VALVE MFG. COMPANY
New York Chicago BOSTON Atlanta Pittsburgh

BE SURE TO FOLLOW THE QUESTIONS AND ANSWERS SERIES IN THIS ISSUE OF POWER HOUSE.

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

Power Production is at the Roots of all Industry

Packing (for rods and valves) plays a very important part in power production.

THEREFORE IT IS IMPORTANT that a packing be selected because of its reputation for LONG SERVICE UNDER HARD CONDITIONS.

TRADE MARK
"PALMETTO"
REG. U.S. PAT. OFFICE

the packing with years of established reputation for long and uniform service.

"PALMETTO" MEANS ECONOMY.

Free working samples to prove it.

GREENE, TWEED & CO.

SOLE MANUFACTURERS

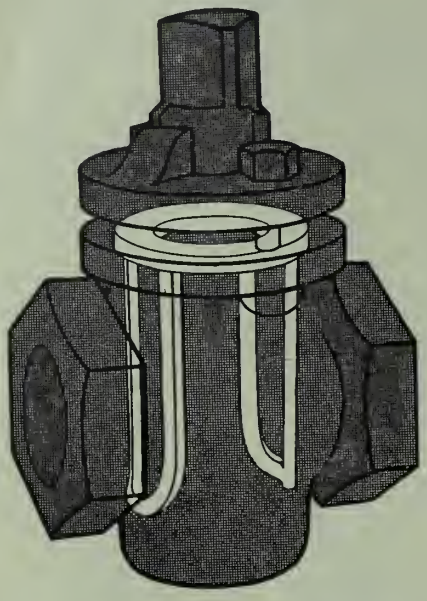
109 DUANE STREET, NEW YORK

Representatives in Canada: The Canadian Fairbanks-Morse Co., Limited, Toronto, Montreal

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

FOR THE HARDEST SERVICE!

Where Temperatures and Pressures are Highest



Where Ground Plug Cocks and Globe, Angle or Gate Valves fail—try a

PRATT AND CADY ASBESTOS PACKED IRON COCK

Asbestos packing against the tapered plug—a combination which defeats every leak tendency under the most severe service. The packing is forced into the grooves under heavy pressure, and with the top ring, effects a complete circle of asbestos to metal around both parts of the cock.

Especially designed and recommended for Hydraulics—Steam—Oil—Gas—Ammonia and Air.

Ask us for catalog.

PRATT & CADY COMPANY, INC.
Makers of Valves, Cocks, Steam Traps and Hydrants
Hartford, Conn.

GENERAL SALES AGENTS

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED
St. John Quebec Montreal Ottawa Toronto Hamilton Winnipeg
Saskatoon Calgary Edmonton Vancouver Victoria

INSTANT HEATING AND NO EXPANSION DANGER

Alberger Tubes of Pure Copper—corrugated instead of straight—increase the heat units over straight tube heaters by more than 50 per cent.

ALBERGER

MULTI-HEAD

—really the chief feature of the *Alberger Water Heater*—eliminates all danger of expansion strains.

Investigation of these two points will show you why the Alberger Heater is backed by a record of economical service as yet unmatched by any other heater.

Horizontal and Vertical Types for boiler feed water, gravity and forced heating systems, hot water service for domestic purposes, etc. Ask for Catalog.

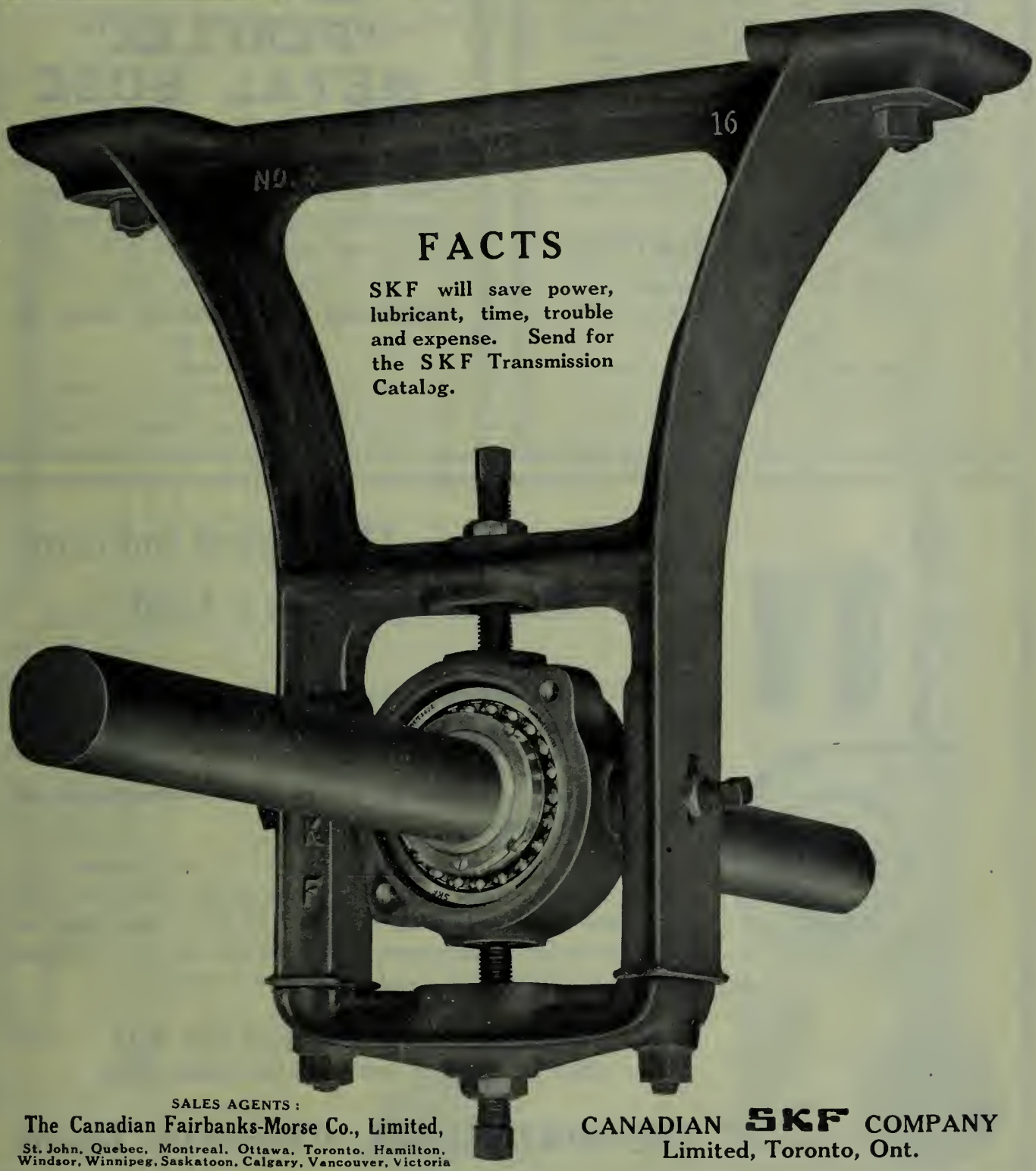
Alberger Heater Company
Buffalo, N.Y.

GENERAL SALES AGENTS:
The Canadian Fairbanks-Morse Co., Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria.

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

SKF



FACTS

SKF will save power, lubricant, time, trouble and expense. Send for the SKF Transmission Catalog.

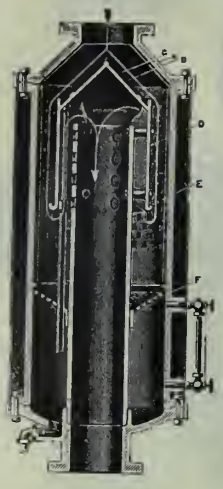
SALES AGENTS :
The Canadian Fairbanks-Morse Co., Limited,
St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

CANADIAN SKF COMPANY
Limited, Toronto, Ont.

THE CANADIAN FAIRBANKS-MORSE COMPANY, LIMITED

III IMPORTANT THINGS

TO CONSIDER ABOUT A SEPARATOR.



I. THE PLAN—Is it sensible, will it work, no matter how large the Separator or how well made?

II. THE SIZE—Is it big enough regardless of plan, will it hold a good dose of water?

III. THE CONSTRUCTION—Is it strong enough, are flanges heavy, how will it look by the side of a nicely finished engine? Send for catalog and note these points in

Sweet's Separators

DIRECT SEPARATOR COMPANY
820 Geddes Street · SYRACUSE, N.Y.

General Sales Agents:
Canadian Fairbanks Morse Company, Limited
St. John, Montreal, Quebec, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria

FOR Steam or Air Drill, Pneumatic Tools, Boiler Flue Cleaning, Syphon Connections, Suction Lines.

For all kinds of Oil, Gasoline, Paints, Hydraulics, Gas.

"PENFLEX" METAL HOSE

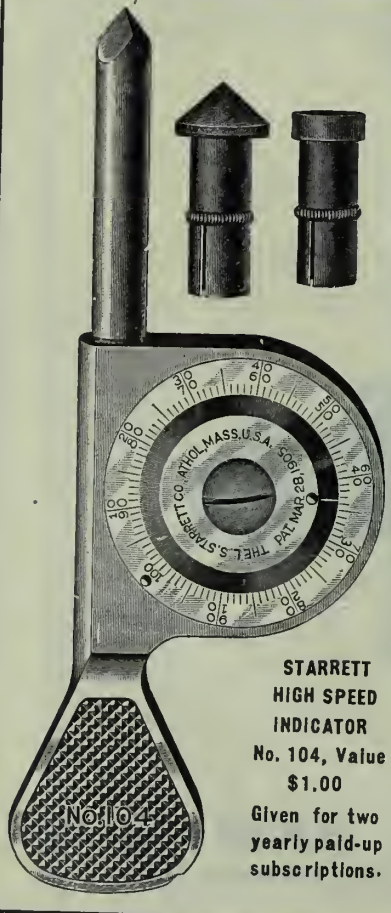
INTERLOCKING

An all Metal Flexible Hose. Manufactured in Bronze or Galvanized Steel. Will withstand highest pressures. Is unsurpassed for durability and pressure resisting qualities.

Large Stock Carried in Canada

Pennsylvania Flexible Metallic Tubing Co.
Philadelphia, Pa.

Canadian Agents:
The Canadian Fairbanks-Morse Co., Limited
St. John, Quebec, Montreal, Ottawa, Toronto, Hamilton, Winnipeg, Saskatoon, Calgary, Vancouver, Victoria



STARRETT HIGH SPEED INDICATOR No. 104, Value $1.00 Given for two yearly paid-up subscriptions.

You May Have This Speed Indicator without Spending a Cent

if you are a subscriber to "THE POWER HOUSE." If you are not a subscriber, send in your own subscription together with two others, and the indicator you are entitled to will be mailed to you immediately.

To subscribers who send us two NEW yearly paid-up subscriptions we will send this $1.00 indicator.

"THE POWER HOUSE" is designed to give Canadian Engineers, Superintendents and Power Users all the latest and best information in the engineering field. A little work among your engineer friends and acquaintances will earn for you this handy indicator without any trouble. Try it and see how easy it will be.

PUBLISHED MONTHLY AT $1.00 PER YEAR
Start in TO-DAY to earn one of these Handy Tools

THE POWER HOUSE 143 University Ave., **Toronto**

THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

CANADA'S DEPARTMENTAL HOUSE FOR MECHANICAL GOODS

GRATON & KNIGHT

Standardized Series LEATHER BELTING

Tanned by us for belting use

A Belting Catechism

What are the Advantages of Leather as belting?
Leather is the standard belting material. When properly tanned for belting its surface will grip the pulley in the most effective manner. Good leather belting is economical and reliable. It will transmit power with 98% efficiency.

How can leather belting be made uniform?
The manufacturer must first set up definite standards of quality—and strictly adhere to them. As he cannot secure belting leather in the open market of uniform quality, he must tan his own hides. He must tan them in sufficient quantity to enable him to select for each belt, pieces up to his standard. These pieces must be uniform in weight, stretch. texture, and quality.

Why should belts be rigidly graded?
A belt is no stronger than its poorest part. The quality of leather varies, and unless each belt is carefully graded, dissimilar qualities get into the same belt. Rigid grading *is* uniformity. Grading should be done by expert judges of belt leather quality, according to fixed standards.

Why is there such confusion in leather belting grades?
Because many belt makers have not standardized their belts, but give the buyer any kind of belt he demands. The result is chaotic.

What is Standardized Leather Belting?
Simply belting that is standardized to meet the needs of the different classes of power transmission—instead of being made to meet theoretical specifications. Transmission requirements can be classified into a comparatively few groups, and there is a standardized belt to fit each one. Standardization *can* be applied to belting just as to any other type of machine part or product. It is common sense in belting.

How does Standardized Leather Belting help the belt buyer?
It insures the selection of the proper belt required to speed up machines, to maintain production, to reduce operating expenses, which cannot be accomplished unless the belt user gets the maximum power through his belts. Standardized leather belting effects this for him and enables him to *know* that he is getting the right brand for highest efficiency and greatest economy—maximum service from every belt and every drive.

How does it work?
Let a Graton & Knight representative make an analysis of your belting requirements. Then get the standardized belt for your work, ordering your belting by work to be done rather than by specification. There is no obligation—there may be a great saving for you.

The Graton & Knight Mfg. Company

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Leather Packings and Sundries

WORCESTER, MASS., U.S.A.

Canadian Representatives: The Canadian Fairbanks-Morse Co., Limited, St. John, Montreal, Ottawa, Toronto, Hamilton, Quebec, Calgary, Edmonton, Vancouver, Windsor, Winnipeg, Victoria.

GRATON AND KNIGHT

Spartan Leather Belting on dry grinders. Hoover Steel Ball Co., Ann Arbor, Mich.

To Our Readers and Advertisers

—Greetings

TO our loyal friends, one and all, we extend the compliments of the season.

We thank you for your steadily increasing interest and patronage. We shall endeavor to show our appreciation by making 1918 an even more helpful year than any that have gone before.

The Publishers
POWER HOUSE

BEHIND the Diamond Trade-Mark on every JENKINS BROS.' VALVE is the 53 years' reputation for

Quality Products and Trustworthy Service

Fig. 106
JENKINS BROS.'
STANDARD PATTERN
BRASS GLOBE VALVE
Screwed

Constant improvement to meet the varying conditions of valve practice and usage since 1864 has made possible the maintenance of the Jenkins Bros.' guarantee.

FIG. 300
JENKINS BROS.'
TYPE "K"
BRASS GATE VALVE
Screwed

"If you will put a genuine JENKINS BROS.' VALVE on the worst place you can find, where you cannot keep other valves tight, and if it is not perfectly tight, or does not hold steam, oils, acids, water or other fluids longer than any other valve, **you may return it and your money will be refunded."**

Leading Engineers no longer buy valve service on manufacturers' say-so. They insist on a definite record of accomplishments—facts. JENKINS BROS.' VALVES invite investigation on a fact basis.

ORDER FROM YOUR DEALER.
Catalogue No. 8 Sent Free on Request.

JENKINS BROS.

LIMITED

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103 St. Remi Street
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95 Queen Victoria Street
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ENGLAND

Agencies in all the Principal Countries of the World

MacLean's Magazine

for JANUARY

Chasing the Submarine—by a Canadian

A CANADIAN, whose name is withheld, in the Motor Boat Patrol Service in the North Sea, tells in the January MacLean's the story of the work and life and triumphs of the Service to which he is attached. It is a fine performance by MacLean's to get this story for the Canadian people. Successes of this sort have made MacLean's go far forward in public favor during past months.

If the horrid and terrible submarine warfare and the conquest of this pest of the deep interest you, learn more about submarines and their capturing in the January MACLEAN'S, and pass on to others the news of this unsigned contribution.

Ships—more ships—and yet more ships

THIS is a very strong article which Miss Agnes C. Laut contributes. As usual she is very well informed. Regarding the duration of the war she voices American opinion when she says that it is likely to be long drawn-out. The United States people are buckling down to a stern struggle. At this time we want very much to read what well-informed, virile thinkers and writers have to say about the war, since things are not any too bright in certain directions. Miss Laut has a good deal to say about the shipping programme of the United States, and certainly she gives facts and sets us thinking as few writers do.

"Jim" by Robert W. Service

A POEM by this strong poet—a poem wrought amid the smoke and hell of battle, yet fanciful and tender. One wonders how men can write fanciful verse amid surroundings that seem so adverse to thinking and writing, yet some gifted can detach themselves and let fancy play; or is it that their minds see through the real and horrible—through the immediate environment into inner things? Whatever it may be, we ought to be glad for the verse that men like Service give us, remembering how and where it is produced.

Adam and Arthur William Brown, Brothers

ADAM BROWN is a Canadian short story writer of large promise. His brother, Arthur William, is one of New York's foremost illustrators. Both brothers have joined their gifts to make Hannibal Helps a mighty good feature of the January MACLEAN'S.

A New Serial by Alan Sullivan

ALAN SULLIVAN'S recent novel, The Inner Door, is being well received. Perhaps we have no better novelist of his type in Canada to-day. He writes books that show introspection and fine analysis. This serial, The Magic Makers, adds venture and mystery to psychological study, and is a rare good thing. Arthur Heming illustrates the story, which begins in Scotland and is transferred to Canada where the stage is set.

The Regular Departments of MacLean's

REVIEW of Reviews, Women at Work, The Business Outlook—are present in goodly measure. Oppenheim's The Pawns Count, Trench Pictures, and first-class illustrations by artists of note help to make the January MACLEAN'S good value for money.

At All News Stands, 20c.

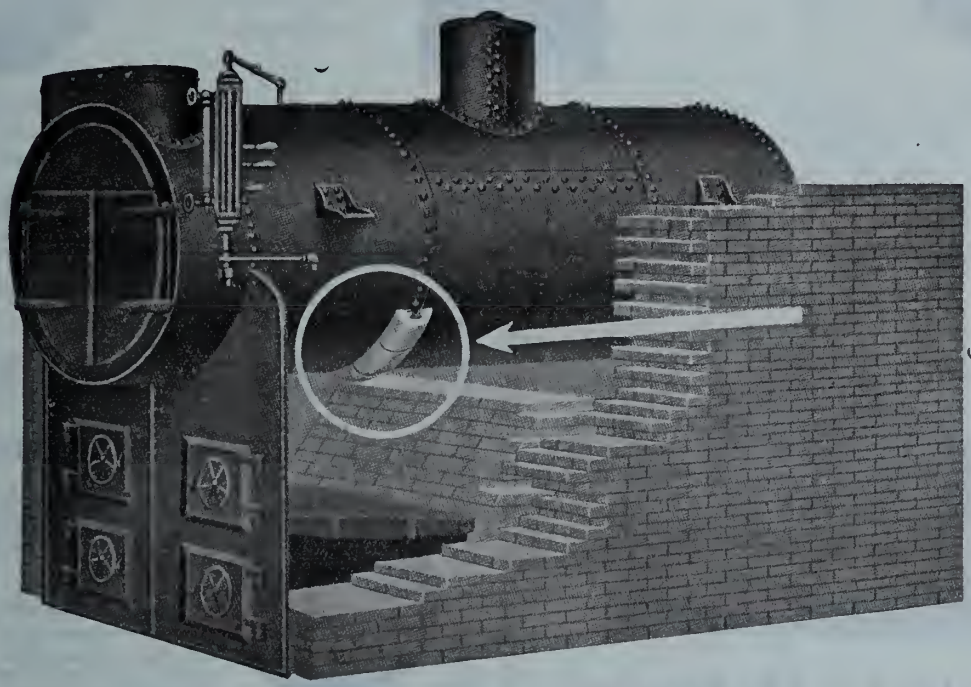
It Only Costs 3⅓ Cents Per Day
To Have
BOILER PROTECTION
Against Fire Cracks, Mud Cracks, and Leaks
AFTER INSTALLING

The National Boiler Girth Seam Protector

U.S.A. Patent Oct. 25th, 1916. Canadian Patent, No. 177295, May 29th, 1917. Foreign Patents Applied for.

Protection

Stops Leaks



Prevents Cracks

Tested, Tried, Proven True

Guaranteed for Two Years from date of erecting. We will replace any part or every part which is proved unsatisfactory FREE OF CHARGE.

PROTECTION IS TRUE ECONOMY AND EFFICIENT SERVICE.

Can be attached to Girth or Patch Seams by anyone.

Write for Catalogue and Price List.

National Boiler Girth Seam Protector Company of Canada

Head Office: 910 NEW BIRKS BUILDING, MONTREAL, P.Q.
Toronto Office: 568 MANNING AVE.

KERR
("New KEYSTONE" Pattern) GATE VALVES

If you have not used any of these New Pattern Valves, specify "KERR" in your next order. We want you to get acquainted with the most reliable valve on the market.

If you have been using them, we are confident that our satisfaction will bring us your repeat orders. These valves will never cause you or your customer the slightest trouble. Their high quality is consistent.

When you buy a "KERR" Valve you get a guaranteed article that is backed by a reliable firm. Many of the largest distributers of valves in Canada have sold "KERR" Valves for over 25 years, and are still recommending them as the "Best Valve." Write us for particulars.

Kerr Engine Co., Ltd., Valve Specialists **Walkerville, Ont.**

Immediate Delivery

324 H.P. B. & W. 2—42" Drums 23' 10" long. 7/16 Shell Plate. Double Riveted lap seam. 144—4" tubes 18' long. Sectional header wrought mild steel. Splendid condition.

500 H.P. Geary type. 2—48" Drums 24' 6" long. 5/8 Shell Plate. Triple riveted double butt strap, longitudinal seam. Steel headers with B.&W. ground joint tube caps. 237—4" tubes 20' long. Splendid condition.

Power Plant Equipment Company
310 Dominion Bank Building, Toronto

UEHLING WASTE METER
COMBINED
CO_2 AND TEMPERATURE RECORDER

Record of CO2 and stack temperature on one chart.

Does your fireman know how much fuel he is wasting? Do you know?

The **Uehling CO_2 Recorder** makes a complete 24 hr. record of your combustion efficiency and the **CO2 indicator at the Boiler Front** holds the fireman responsible.

Get more **Steam** per pound of **Coal** and reduce your annual fuel consumption.

CO2 Indicator for Boiler Front

Let us know the number and size of your boilers and coal consumed per year, upon receipt of which information we will be glad to send you full particulars.

Let us hear from you. We are pioneers in the manufacture of Indicators and Recorders for Power Plant purposes.

Send for our Bulletin No. 110.

Uehling Instrument Company
2008 Empire Building New York City

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

Outlast the Pipe

Moreover, Dart Unions are permanently tight. The heavy iron parts will not stretch; they will not pull apart. And there can be no rust, no corrosion, no leakage; for Dart Unions are

Bronze to Bronze at the Joint

Ball-shaped seat makes it easy for inexperienced hands to make lastingly tight connections whether pipes are in or out of alignment.

Two new Dart Unions free for any one you find imperfect.

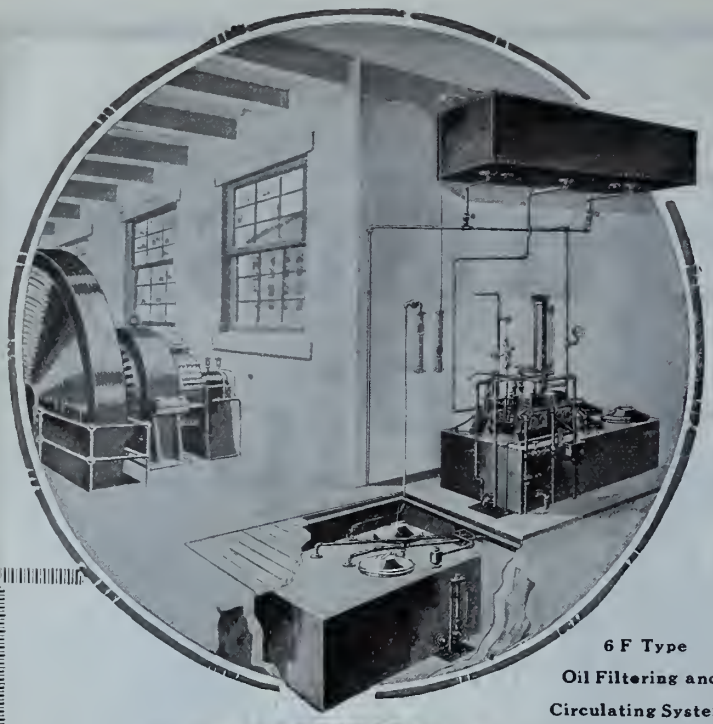
Order Dart Unions from any first-class supply house anywhere.

Made in Canada by

Dart Union Co., Limited

Toronto Ontario Canada

If any advertisement interests you, tear it out now and place with letters to be answered.



6 F Type
Oil Filtering and
Circulating System

Results that Count

The Bowser System makes good results a sure thing.

Wherever it is installed there is more uniform lubrication of machines, without loss of oil; less depreciation of equipment; fewer repair bills; a better spirit among employees, and—increased profits, all of which are good, strong reasons why the Bowser should be in your plant.

The Bowser stores and supplies new oil—collects dirty oil—purifies it, makes it good as new—returns the proper supply to points of use wherever located. Its simplicity, durability, and ease of operation are reasons for its popularity in all well regulated plants.

"Results that Count" always follow its use—we'll be glad to tell you more about it if you drop us a line.

BOWSER ESTABLISHED 1885

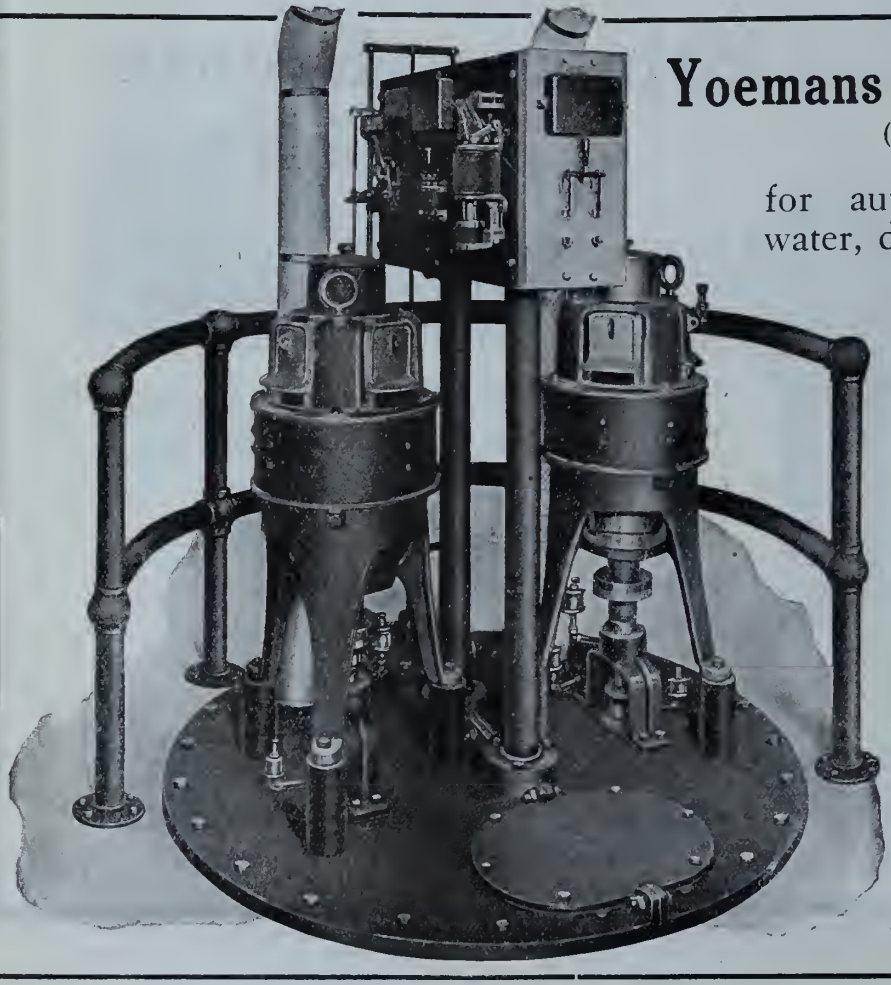
Oil Circulating
and Filtering Systems

S. F. Bowser & Co., Inc.,
TORONTO, ONTARIO

Sales Offices in All Centers

Representatives Everywhere

BOWSER SERVICE



Yoemans Electric Bilge Pump

(*Single and Duplex*)

for automatically raising surface water, drainage and sewage in basements below level of street sewers, municipal sewerage systems, etc.

Illustration shows No. 3 Grade 1 Duplex Bilge Pumps installation.

Bulletin No. B-3000 gives full particulars.

We can supply you with almost anything needed in the power plants.

We are problem-solvers—tell us your troubles, we can invariably help you.

DARLING BROS.
LIMITED
Toronto Montreal Winnipeg Vancouver

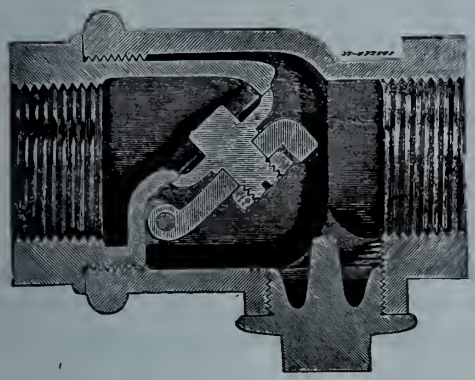
The Genuine

"McSHANE"

Straightway Swinging

CHECK VALVES

Sectional View



BRASS OR IRON

SCREWED OR FLANGED

For use Upright or Horizontally

Always Ready for Inspection

Suitable for Pressures up to 250 lbs.

T. McAVITY & SONS

LIM TED

Wholesale and Retail Hardware
Brass and Iron Founders

ST. JOHN N.B.
CANADA

Montreal Toronto Winnipeg Vancouver
London, England Durban, South Africa

Established 1834

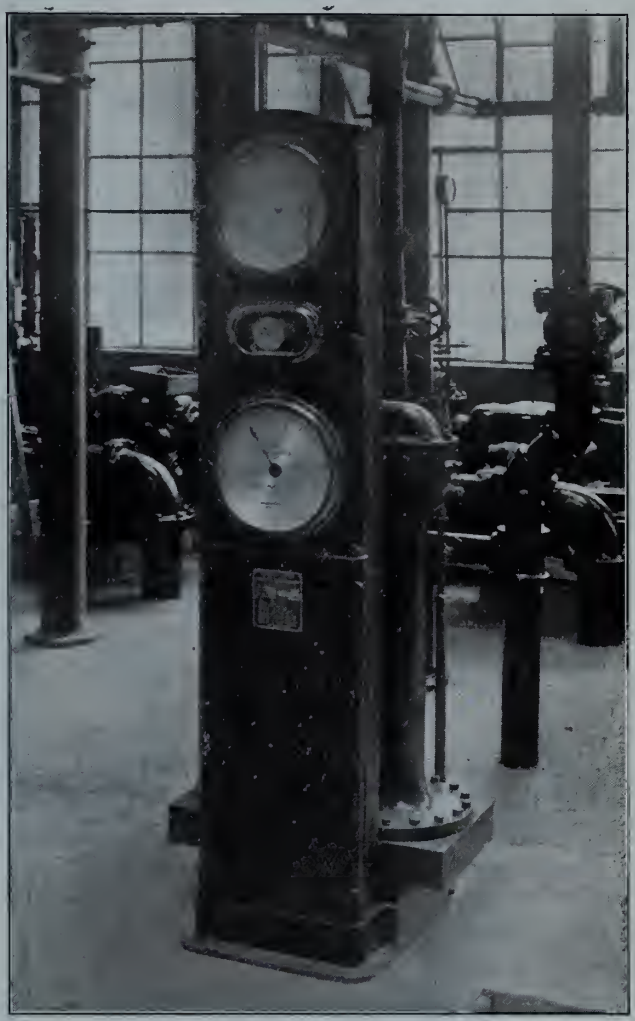
WOULD YOU

Hire a Foreman to Watch a Job and Then *Blindfold* Him?

NOW WOULD YOU?

WE SHOULD HOPE NOT.

THEN *WHY* KEEP YOUR OPERATING ENGINEER IN THE DARK REGARDING CONDITIONS IN HIS PLANT,—THINGS HE SHOULD *KNOW* ABOUT AND NOT HAVE TO GUESS AT.



VENTURI METER AT GOODYEAR TIRES.

VENTURI

STEAM & BOILER FEED METERS

SUPPLIED THE REQUISITE DATA TO ENABLE THE ENGINEER AT THE TORONTO GENERAL HOSPITAL TO SAVE SUFFICIENT COAL IN THREE MONTHS TO PAY FOR ALL THE METERS.

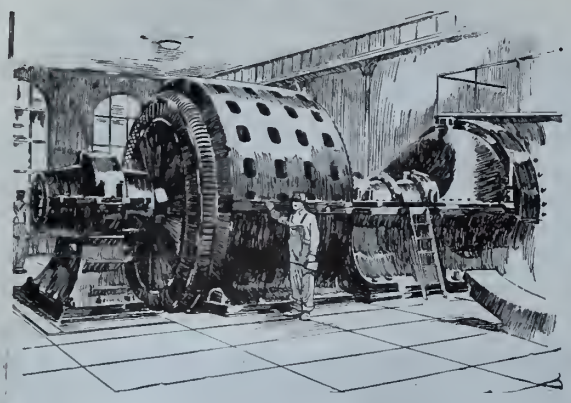
WHY NOT WRITE US NOW?

Allen General Supplies Ltd.

205 YONGE ST., TORONTO

Representing

THE BUILDERS IRON CO.



Hard Dustless Floors

The wear and tear on machinery each year caused by crumbling and dusting floors can be measured in millions of dollars. Unless you are using an efficient floor covering you are contributing your share to this waste. The ideal floor coatings for every power house are

R.I.W. CEMENT FILLER & CEMENT FLOOR PAINT

REMEMBER IT'S WATERPROOF — REG. U.S. PAT. OFF. — PATENTED AS TO PORTLAND CEMENT FEB 27, 1906

These "R.I.W." products stop instantly the crumbling of concrete floors. They prevent silicious dust particles from walls and floors, from injuring contact points and covering everything with dust.

In addition, these materials are oil-proof and water-proof, and will protect floors from decomposing effects of acids and decomposing chemicals. They have a record behind them of continuous success since 1905.

For complete and interesting literature, write Dept. 59.

TOCH BROTHERS

Technical and Scientific Paint Makers since 1848

320 Fifth Avenue, N. Y.

Works: New York; London, Eng.: Toronto, Can.

R.I.W.

REMEMBER ITS WATERPROOF

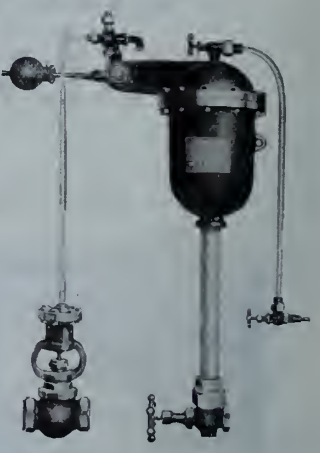
REG. U.S. PAT. OFF.

STEEL NEED NOT RUST!
WOOD NEED NOT ROT!
NOR CONCRETE DUST!

FEED WATER HIGH OR LOW — DANGER!

Needless is the risk you run every day you do without the VIGILANT FEED WATER REGULATOR. Guaranteed to keep water level within 1/4" of middle gauge, it is a positive preventive of accidents due to high and low water.

Nothing about the Vigilant to get out of order. It cannot fail. Write for booklet.



The Chaplin-Fulton Manufacturing Company

28 Penn Avenue - - Pittsburgh, Pa.

Davis Pressure Regulators Save Steam

Don't Waste Steam

You carry high boiler pressure for emergencies and peak loads, but are you sure this reserve is not slipping away? You know only too well the cost of coal—conserve it by keeping your steam pressure under full control with

DAVIS PRESSURE REGULATORS

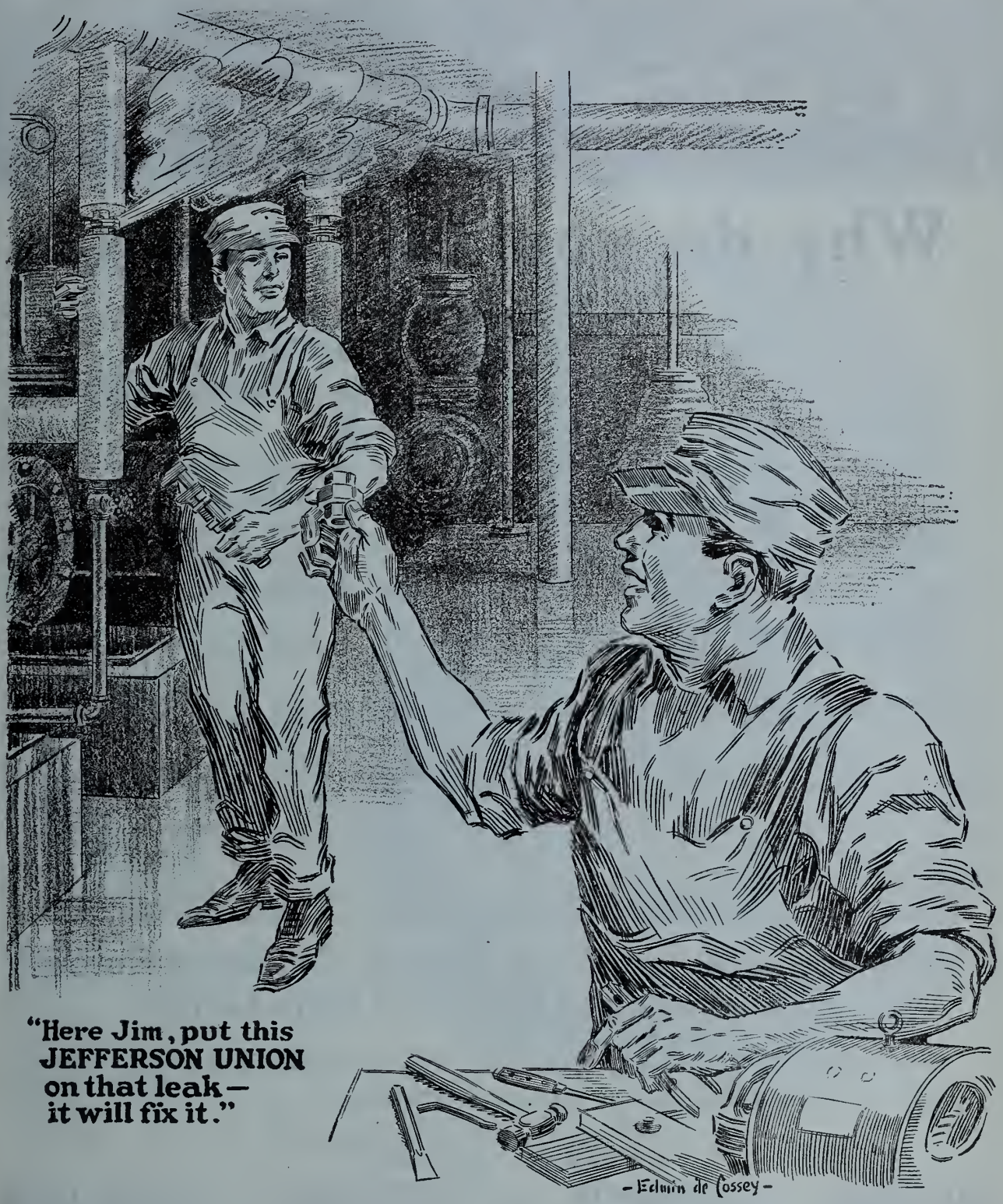
Put these automatic valves to work wherever you can use less than boiler pressure. The cost is trifling and the saving big. Forty years on the market is enough to prove they are built right. Send for catalog. It will show you a way to cut costs.

G. M. DAVIS REGULATOR CO.

434 Milwaukee Avenue

Chicago - - - Illinois

JEFFERSON UNIONS



Lexington, Massachusetts

If any advertisement interests you, tear it out now and place with letters to be answered.

LACO NITRO LAMPS COST LESS

Why do you buy lamps?

To give money to a lamp manufacturer--to consume current, or to actually get light?

The following tabulation of actual laboratory test proves that cheap bulbs are expensive even if given to you free of charge.

NAME OF LAMP	WATTAGE AND CANDLE POWER CLAIMED FOR TESTED LAMPS	ACTUAL CANDLE POWER OF TESTED LAMPS	ACTUAL WATTAGE OF TEST LAMPS	COST 1000 C. P. LIGHT FOR 1000 HRS. AVERAGE COST CURRENT 2½¢ PER K.W.HR.			1000 HOUR LOSS
				LAMPS NEEDED	TOTAL WATTS USED	1000 HR. COST	
LACO NITRO	100	111.5	104	9	936	$23.40	NONE
COMPETING LAMP "A"	100	78.5	101	13	1313	32.83	$ 9.43
" " B	100	87.5	109.5	12	1314	32.85	9.45
" " C	100	66.9	103	15	1545	38.63	15.23
" " D	100	63.0	100	16	1600.	40.00	16.60

A Saving of 30% to 50% in Current Consumed During 1000 Hours by Using Laco Nitro Lamps

Without cost to you, our nearest office will have official laboratory tests made of any of your lamps to prove our claims.

STOCKS AND WAREHOUSES AT

MONTREAL TORONTO WINNIPEG VANCOUVER

Canadian Laco-Philips Company, Limited

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

"The Light That Gives MORE LIGHT"

Actual Cost Computed From Table

Cost of 13 competitive lamps (assumed low average cost of $1.00 each)	$13.00	
Cost of current to produce 1000 candle power for 1000 hours (average)	36.08	$49.08
Cost of 9 Laco Nitro Lamps at maximum cost of $1.65 each....	$14.85	
Cost of current to produce 1000 candle power for 1000 hours.....	23.40	38.25

Saving - $10.83

LACO NITRO LAMPS ARE GUARANTEED

60 watt size ..... 700 hours
100 to 1000 watt size.....1000 hours
and many users get two or three times this service.

Can you afford to buy cheap lamps when Standard Laco Nitro Lamps effect such savings?

Ask your dealer to-day about these lamps.

Canadian Laco-Philips Company, Limited

STOCKS AND WAREHOUSES AT

MONTREAL TORONTO WINNIPEG VANCOUVER

Canadian Association of Stationary Engineers

Incorporated May, 1887 — Incorporated at Ottawa, June, 1917

An organization having as its aims and objects:—

To promote the knowledge of its members in the art and science of Steam Engineering.

The dissemination of information beneficial to the members of the association in the discharge of their calling.

To further and protect the interests of competent engineers, and receive such as members of this organization.

To secure, through proper legislation, the greatest security in operation of steam plants.

To assist unemployed members to secure positions.

To maintain freedom of action between employer and employee.

The members of the Association subscribe to the above in the full belief that ability and knowledge of one's profession are necessary to insure the highest degree of success.

Labor Study Energy

These three essentials have been responsible for the success of the world's greatest men. They are no less essential for yours. We cannot all become great, but this fact does not lessen the necessity for the exercise of these essentials in our individual occupations. Cool, calm, calculating judgment characterizes the successful power house operator of to-day. The demands on the engineer of to-day are many, and the obstacles in his path are great. To assist in the overcoming of these and help the accomplishment of great works, material, moral and educational, is the desire of all our members.

The benefits accruing from association with members of his fraternity, the opportunity to benefit by their experience, and the inspiration to greater effort by reason of their success render membership in this association indispensable to all progressive engineers.

If you are interested in such an organization and live where less than fifteen engineers are located, send for a copy of our constitution and application blanks for admission to nearest branch lodge. If there are more than fifteen engineers in your community, get together and send for particulars regarding formation of a branch lodge.

J. H. HALE, General Secretary, C.A.S.E.

230 Caroline Street — Hamilton, Ont.

D.K.McLaren's

GENUINE BRITISH-OAK TANNED

LEATHER BELTING

Drip! drip! drip! of water will bore a hole through stone. Just as surely will slip! slip! slip! of inefficient belting eat away your profits.

To Turn Your Pulleys Without Loss of Power

use D. K. McLaren's Leather Belting—the nearest to stretchless belting that the wide world knows.

Flawless back leather alone is used, and it is tanned by the British-Oak Method to make it serve from year-end to year-end without "puttering" attention—without slippage, without breakage, without needing to be "taken up."

Write for booklet of belting facts.

D·K·McLAREN LIMITED

ST. JOHN, N.B.
90 Germain St.

TORONTO, ONT.,
194 King St. West

VANCOUVER, B. C.
849 Beatty St.

HEAD OFFICE AND FACTORY: 351 ST. JAMES ST., MONTREAL, P.Q.

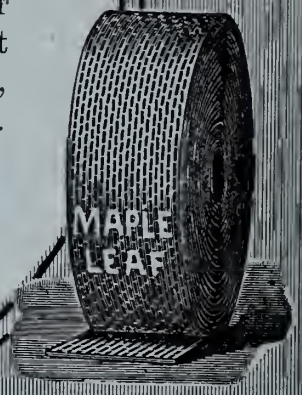
"Maple Leaf" Brand

Stitched Cotton Duck Belting

THE BEST FOR ALL KINDS OF BELTS

Is strong, durable, economical and true running. Being thoroughly waterproof, it is equally good for running in wet or dry places. As a main drive belt "MAPLE LEAF" cannot be excelled, and for conveyors is in great demand. A trial belt will convince you.

Write for prices and samples.



Dominion Belting Co., Ltd.,

HAMILTON, CANADA

This book should be in the hands of every pump user. A postal will bring your copy promptly

MARSH and AMERICAN

Steam and Power Driven Pumps and Air Compressors

Marsh and American Pumps are especially adapted for long, hard service because they are *extra heavy* in design and of *extremely rigid construction.* Every unit is built amply strong to withstand 24-hour-a-day service and to stand up under any unforeseen strain which may be placed upon it. Piston rods on the steam pumps are extra large and made of solid bronze. The water ends are equipped with heavy cast bronze removable bushings.

This superior construction not only insures continuous and satisfactory operation, but practically *eliminates expensive shut-downs.* Marsh and American Pumps are the product of over 25 years' experience in the design and construction of high grade pumping machinery. Over 135,000 in actual service throughout the world.

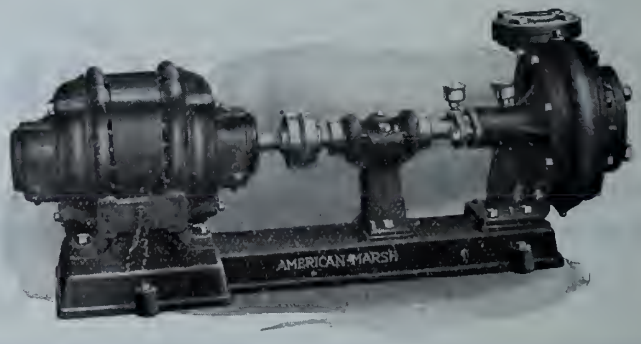
The AMERICAN-MARSH LINE OF CENTRIFUGAL PUMPS is composed of both single and double suction types which are designed for heads up to 125 feet. They are equipped with wide ring oiled bearings and the single suction type has overhanging casing enabling the discharge to be taken at any angle desired.

CANADIAN AGENTS

A. R. Williams Machinery Co., Toronto.
Williams & Wilson, Montreal.
London Engine Supplies Co., London, Ont.
Stuart Machinery Co., Winnipeg.
Mechanics' Supply Co., Quebec, Que.
Gorman, Clancy & Grindley, Limited, Edmonton and Calgary.
Taylor Engineering Co., Ltd., Vancouver, B.C.

American Steam Pump Company

Battle Creek, Mich.



American-Marsh Centrifugal Pump.

If what you need is not advertised consult our Buyers' Directory and write advertisers listed under proper heading.

COOL RUNNING EQUIPMENT

is a matter principally of securing a lubricant that possesses a high lubricating factor and a low melting point. Such a lubricant will never let any bearing become overheated and will assure you of cool running equipment.

ALBANY GREASE

is a pure tallow compound with a high lubricating factor and a low melting point. It can be used on any bearing in your plant and in any kind of grease cup. Send for a trial quantity and an Albany Cup—now.

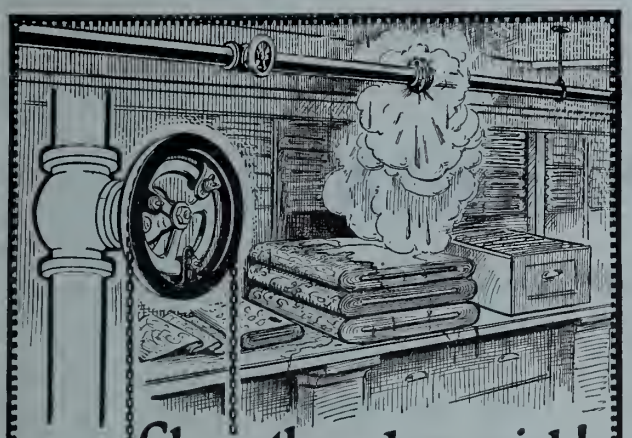
Albany Lubricating Co.
708-10 Washington Street
NEW YORK

"This core is as good as new, George. Did CLING-SURFACE keep it that way?"
"Sure—this rope ran in the open for 5 years, too."

GEORGE knows!

He had the care of their belts
and ropes.
The firm had a rope drive on the roof
in Buffalo,
exposed to rain, wind, sleet and snow
off Lake Erie,
and smoke from the nearby factories.
These things hurt a rope drive.
They dry out the greases
and the fibres *grate* together.
The "core" is ground to powder.
The rope becomes hollow, limp,
DANGEROUS—it is no longer strong.
But by treating it with CLING-SURFACE
these fibres were kept lubricated.
They did not *grate,*
but *slid,* like a well-oiled bearing,,
and the rope *lasted.*
After *five* years on the roof it was
still good for service
because of CLING-SURFACE.
This semi-liquid
"easy-to-use"
belt and rope treatment
will also prevent slipping
and let you remove some of that tension.
Ask for our Rope Folder P384
or order a can for 60 days' trial.
Remember,
Use CLING-SURFACE
and you won't need belt or rope dressings.

Cling-Surface Co
1057 Niagara Street
Buffalo New York
U S A



Close the valve, quick!

Then some one chases around for a ladder. The ladder slips, the workman falls, and all the time steam is pouring from a leaky joint.

Babbitt
—Adjustable—
SPROCKET RIM
IS FOR JUST SUCH SITUATIONS

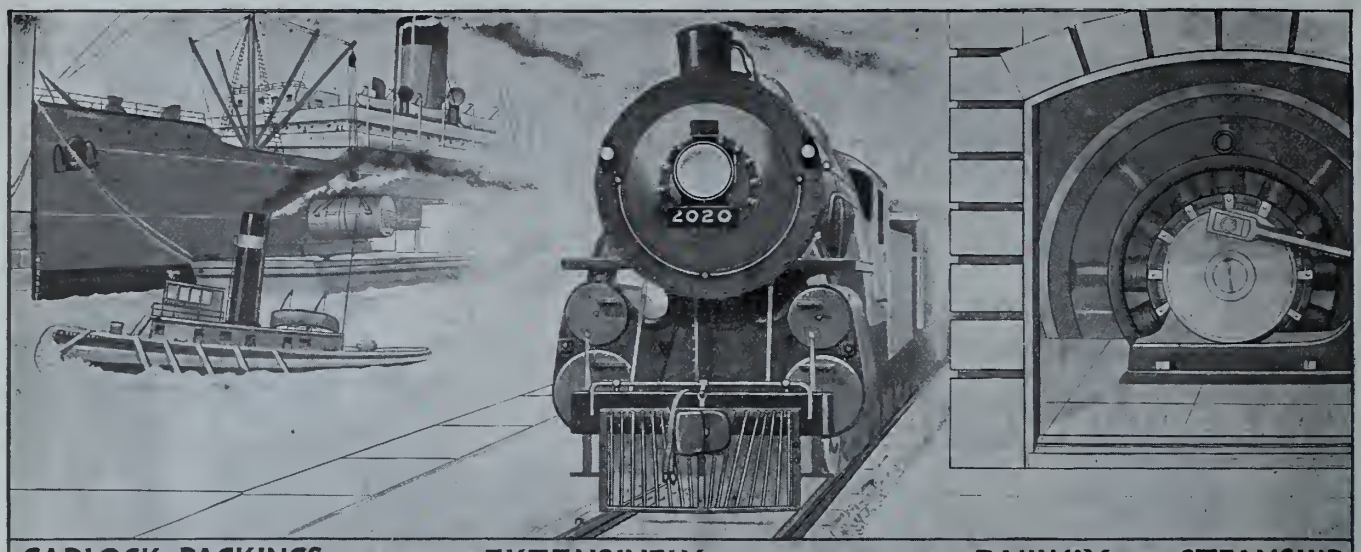
Just a Pull on the Chain and the Valve is Closed.

Attach one to each of your valve wheels. They will fit any size and it takes only five minutes to attach them.

Your dealer will show them to you, or write us direct and we will send you an illustrated pamphlet.

Babbitt Steam Specialty Co.
NEW BEDFORD, MASS.

If any advertisement interests you, tear it out now and place with letters to be answered.



GARLOCK PACKINGS ARE USED EXTENSIVELY BY THE GREATEST RAILWAY AND STEAMSHIP LINES AND IN THE LARGEST STATIONARY POWER PLANTS THROUGHOUT THE WORLD

In the Three Great Branches of Steam Engineering

Where speed and economy are paramount, where a hot rod or a blown out gasket might mean a schedule broken or contract lost,

GARLOCK PACKINGS

are used generally. Under the most trying conditions of service Garlock Packings have proved their superiority. Let us suggest a cure for that rod or joint that "won't stay packed." We invite you to submit your packing problems.

The Garlock Packing Company - Hamilton, Ont.

Branches:

Montreal, Quebec - - - - - 409 Shaughnessy Building
Toronto, Ontario - - - - - 404 Continental Life Building
Winnipeg, Manitoba - - - - - - - Galt Building

Omalley-Beare Valve

3 or 4 Renewal Plates
on Head.

3 or 4 Renewal Plates
on Seat.

NO REGRINDING.

If Valve Leaks, Remove
Worn Plates

PRESTO!

a New Valve.

TRADE MARK

MAGNOLIA ANTIFRICTION METAL

TRADE MARK

THE STANDARD OF MEASURE

WAGNER MILLING COMPANY
Manufacturers of Flour, Feed and Meal.

Magnolia Metal Co., Pedro, Ohio, 5/28/16

Gentlemen,—I use Magnolia Metal. I have had a great many years' experience around power plants, cement plants, saw mills and blast furnaces, and can say that we always consider "Magnolia" Metal the Standard by which we measure other metals.

I am engaged in a small business of my own and still use Magnolia when necessary.

Yours truly,

O. L. HARPER, Sec. and Treas.

PRACTICAL ENGINEER POCKET BOOK:
Over 600 pages. A valuable reference work imported from England and sold as an advertising medium at the low price of 40c post paid.
Address Montreal Office.

SOLD BY LEADING DEALERS EVERYWHERE OR BY
MAGNOLIA METAL CO.
OFFICE AND FACTORY:
225 St. Ambroise St. MONTREAL

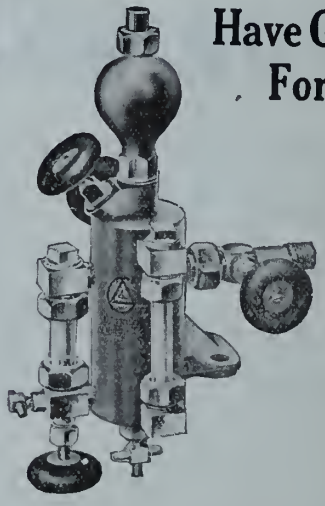
A Coupling as Strong as the Shaft

When the bolts on the Spiro are tightened the coupling grips the shaft over its entire area.
The spiral slot in the sleeve, shown in the cut below, allows a tremendous gripping force to be exerted. This gripping force in the Spiro is 50% greater than in any other coupling. That is an actual fact—not just an advertising statement.
There are no keys to break or work loose. There is no danger of a slip.
When you next buy, get Spiro. Get our catalog in the meantime for information on other power appliances.

Canadian Bond Hanger & Coupling Co.,
Limited
Alexandria, Ont.

Detroit Lubricators

Have Given Satisfaction For Forty Years.



Built in a sufficient variety of styles to lubricate properly every type of steam engine, pump, gas engine, air compressor, etc.

Send to-day for catalog L 1. The information on lubricating devices contained in it will be valuable to you.

THEIR efficiency holds over half the world's trade.

Makers of Stewart Carburetors.

CANADIAN DETROIT LUBRICATOR COMPANY, LTD.
WALKERVILLE, ONT.

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

MORSE
SILENT CHAINS

Let MORSE Engineers Design Your New Drive

The Only 99% Efficient Power Transmission

FROM ¼ H.P. TO 5000 H.P.
THEY MAKE GOOD

Only by using MORSE CHAINS can you get the MOST out of your Machines and Motors

The MOST is little enough just now.

POWERFUL
SILENT ENDURING

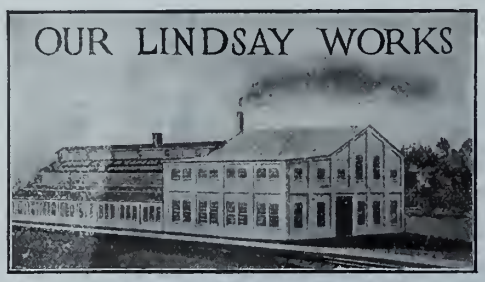
MORSE CHAIN COMPANY, Ithaca, N. Y.

The Largest Manufacturers of Silent Chains in the World

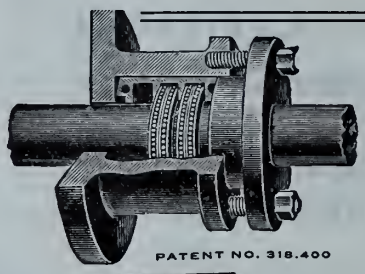
If any advertisement interests you, tear it out now and place with letters to be answered.

HINTS TO BUYERS

Water Turbines, Hydraulic Governors, Centrifugal Pumps



Boving Hydraulic & Engineering Co., Limited
LINDSAY, ONTARIO


PATENT NO. 318,400

PAT. NO.	500,899	PAT. NO.	829,116
" "	534,104	" "	830,530
" "	602,328	" "	856,103
" "	854,541	" "	878,238
" "	854,542	" "	894,537
" "	725,368	" "	895,791
" "	774,490	" "	898,068
" "	775,193	" "	905,103
" "	775,194	" "	934,629
" "	791,300	" "	979,206
" "	805,869	" "	1000.76

Why not Buy the Best, when in market for Packing?

HOLMES' Metallic Packing
Is Guaranteed 3 Years

Lasts many times longer. 30 days' trial. Less oil. No cutting. Easily applied to any Steam Engine, Air Compressor or Gas Engine. Satisfaction or no pay. Write us.

HOLMES METALLIC PACKING CO., Wilkes-Barre, Pa.
Incorporated 1897

THE LADD VERTICAL WATER TUBE BOILER

The Goldie-McCulloch Co., Ltd.
Galt, Ontario

Canadian licencees under patents 162401 and 162402 dated May 4, 1915.

The George T. Ladd Company,
Pittsburgh, Pa.

Owners and manufacturers for the United States.

Write for new Catalogue No. 17.

DOMINION COAL COMPANY LIMITED

"Dominion" and *"Springhill"* BITUMINOUS STEAM *and* GAS COALS

GENERAL SALES OFFICE
112 St. James St. Montreal

McDANIEL IMPROVED STEAM TRAP

FOR HIGH OR LOW PRESSURE.

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators.

SEND FOR CATALOGUE.

THE GARTH COMPANY
26 Craig Street MONTREAL, CAN.

WATSON & McDANIEL CO.
No. 146 N. 7th Street, PHILADELPHIA, Pa.

NOTICE

TO

Stationary and Hoisting Engineers

Everyone operating a STATIONARY steam plant of 50 h.p. or over in the Province of Ontario must hold a Stationary Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Everyone operating a HOISTING steam plant working at a pressure of 20 pounds or over, irrespective of horse power, and used for hoisting in structural operations or excavating purposes, in the Province of Ontario, must hold a Hoisting Engineer's Certificate from the Board of Stationary and Hoisting Engineers. Anyone operating such a plant without a Certificate is liable to the penalties set forth in the Stationary and Hoisting Engineers' Act.

Application forms for obtaining STATIONARY or HOISTING Engineers' Certificates, may be had upon applying to the Chairman.

HON. F. G. MACDIARMID, Minister of Public Works and Highways. W. C. McGHIE, Chairman of Board.
W. A. RIDDELL, M. A. PH. D., Superintendent, Trades & Labour Branch.

If what you need is not advertised, consult our Buyers' Directory and write advertisers listed under proper heading.

EVERY CHAIN
The Chain of EVERY Williams' "Vulcan" Chain Pipe Wrench has withstood a strain almost to its elastic limit. It can do it as often as you please. If you strain it beyond this point it will stretch before breaking. It is the untested chain that breaks suddenly under a partial load. Avoid needless risk. A chain should give warning of impending failure.
TESTED
J.H.WILLIAMS & CO.
THE WRENCH PEOPLE
RICHARDS STREET BROOKLYN, N.Y. CITY

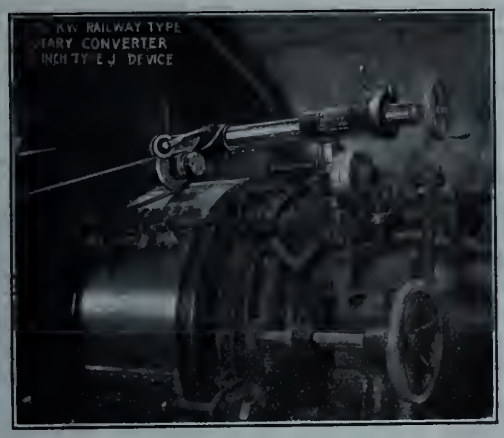
Consult Power House Buyers Directory Pages 79-86

WHY do our PUMP installations always bring repeat orders?

Find the answer in a trial order to

THE SMART-TURNER MACHINE CO.
Limited

HAMILTON, - - CANADA



COMMUTATOR TRUING DEVICE

Trues your commutator without removing armature from its bearings. Send for Booklet No. 5.

Jordan Bros., Inc.
82 Beekman St. New York City, N.Y.

Canadian Representative :
CANADA SALES CO., 183 Church Street, Toronto, Canada

BOILER INSPECTION

The Steam Boiler Act, Chapter 252 R.S.O., 1914 With Amendments Chapter 58—6, George V.

STEAM BOILERS.

All Steam boilers constructed for use in Ontario must be built from designs which have been approved and allotted a registration number by the Steam Boiler Branch.

Used boilers, boilers sold or exchanged, and unregistered boilers brought into the Province must be inspected prior to being put into operation.

Notice of repairs to steam boilers, stating the nature and extent of same, must be sent to the Steam Boiler Branch, and should such repairs be considered extensive by the Chief Boiler Inspector, the boilers will require to be inspected.

In each and every case the inspections must be made by Inspectors authorized to inspect boilers under the Steam Boilers Act, who are employed only by the Steam Boiler Branch of the Department of Public Works. Official certificates with the maximum working pressure stated thereon are issued to the owners of the boilers so inspected.

STEAM PIPING.

Drawings and Specifications of all high pressure steam piping must be approved and registered by the Steam Boiler Branch before any work of installation is commenced. The drawings submitted should show clearly the dimensions and layout of the main steam lines. Full particulars should be given as to the material used in the construction of the piping, and all valves and other fittings used in connection therewith must be of approved make.

Any deviation from the above requirements shall be deemed a violation of the Steam Boilers Act.

All communications in this respect should be addressed to the Steam Boiler Branch, Department of Public Works, Parliament Buildings, Toronto.

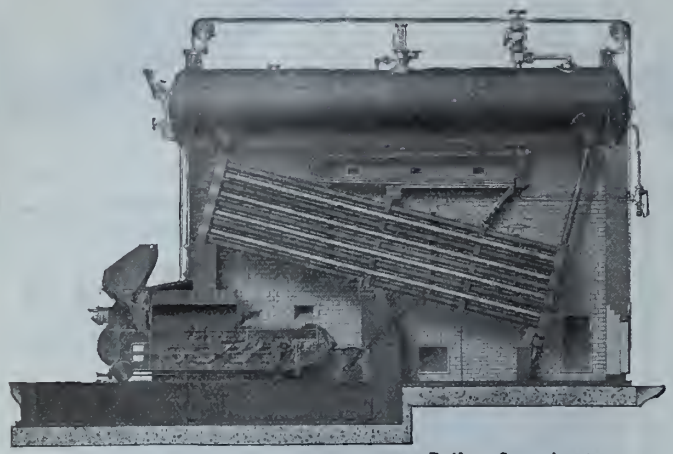
HON. F. G MACDIARMID,
Minister of Public Works and Highways

W. A. RIDDELL, M.A. Ph.D.,
Supt. Trades & Labour Branch

D. M. MEDCALF,
Chief Inspector of Steam Boilers.

"ALL BRITISH"
"B.&W." PATENT WATER TUBE STEAM BOILERS

HIGHEST ECONOMY, SAFETY, DURABILITY. OVER 17,000,000 H.P. IN USE.



Babcock & Wilcox Patent Water Tube Steam Boiler, Superheater and Mechanical Stoker.

ALSO

Steam Superheaters
Mechanical Stokers
Coal-Handling Machinery
Piping, Feed Water Heaters
Water Softeners and Purifiers
and **ELECTRIC CRANES**

BABCOCK & WILCOX, Limited

HEAD OFFICE FOR CANADA - COLLEGE ST. (ST. HENRY), MONTREAL
TORONTO OFFICE, TRADERS BANK BUILDING

The Number Is Everything

Economy in cutting metal with hack saws is so important that nowadays every metal and every shape has its own best hack saws.

Even though every

Starrett Hack-Saw

is made of the best material — tungsten steel—and made right in every way, random selection will seldom if ever give best results. Page 208 of Starrett Catalog No. 21CD lists the uses of various Starrett Hack Saws and in this list will be found a saw best suited to every job.

The L. S. Starrett Co.
The World's Greatest Toolmakers
ATHOL, MASS.
42-746

The Wrench of 25% Greater Efficiency

TRIMO PIPE WRENCH

Two new features have been recently added to the Trimo Pipe Wrench, namely Nut-Guards, in all sizes, and unbreakable steel frames, in leading sizes.

The Nut-Guards prevent the accidental rotation of the nut while in use.

These improvements add 25% to the usefulness of the tool.

The Trimo Pipe Wrench is made with wood handles in 4 sizes, 6-in., 8-in., 10-in., 14-in. and in steel handles in all sizes, 6-in. to 48-in. inclusive.

All Trimo Pipe Wrench parts are interchangeable.

The inserted jaw in the handle can be readily replaced when worn, thus adding to the life of the tool.

Nut with Nut-Guards

Inquiries from Importers and Dealers Solicited. Send for Catalogue No. 55.

TRIMONT MANUFACTURING CO.
Cable Address: Triwrench
Code: Western Union
Roxbury (Boston) Mass., U.S.A.

POWER HOUSE BUYERS' DIRECTORY

If what you want is not listed here write us, and we will tell you where to get it. Let us suggest that you consult also the advertisers' index facing the inside back cover, after having secured advertisers' names from this directory. The information you desire may be found in the advertising pages. This department is maintained for the benefit and convenience of our readers. The insertion of our advertisers' names under proper headings is gladly undertaken, but does not become part of an advertising contract.

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Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

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Can. H. W. Johns-Manville Co., Toronto, Ont.

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Homestead Valve Mfg. Co., Pittsburgb, Pa.
York Mfg. Co., York, Pa.

AMMONIA PURIFIERS
Frick Co., Waynesbo.o, Franklin Co., Pa.
York Mfg. Co., York, Pa.

AMMONIA TANKS
Waterous Engine Works Co., Brantford, Ont.

ARCHES, COMBUSTION CHAMBER
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D'Este Co., Julian, Boston, Mass.

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BELT LACING, LEATHER
Graton & Knight Mfg. Co., Montreal.

BELT TIGHTENERS
Waterous Engine Works Co., Brantford, Ont.

BELT PULLEYS
American Pulley Co., Philadelphia, Pa.
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BELTING, BALATA
Federal Engineering Co., Toronto, Ont.

BELTING, LINK
Graton & Knight Mfg. Co., Montreal.
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BELTING, STITCHED COTTON DUCK
Dominion Belting Co., Hamilton, Ont.

BELTING, LEATHER
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Graton & Knight Mfg. Co., Montreal.
D. K. McLaren Ltd., Montreal.

BELTING, RUBBER
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Goodyear Tire & Rubber Co., Toronto.
Jeffrey Manufacturing Co., Montreal.
Peerless Mfg. Co., New York, N.Y.

BELTING, WOVEN COTTON
Federal Engineering Co., Toronto, Ont.

BINS, COAL, COKE AND ORE
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Can. Sirocco Co., Windsor, Ont.
C. T. Coe Co., 10 Johnston St., Newark, N.J.
Coppus Eng. & Equip. Co., Worcester, Mass.
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Can. Economic Lubricant Co., Montreal, Que.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

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Lunkenbeimer Co., Cincinnati, O.

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Bawden Macbine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Mason Regulator & Engineering Co., Montreal.

BOILER GRAPHITE
Joseph Dixon Crucible Co., Jersey City, N.J.

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Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Ltd., Montreal, Que.
Inglis Co., The John, Toronto, Ont.
Lunkenbeimer Co., Cincinnati, O.
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Babcock & Wilcox, Ltd. Montreal.
Canadian Griscom-Russell Co., Ltd,, Montreal.
Cole, Ltd., Geo. W., Toronto.
Mason Regulator & Engineering Co., Montreal.

BOILER SEAM PROTECTOR
National Boiler Seam Protector Co., Montreal.

BOILER SETTINGS
Beveridge Paper Co., Montreal.
Gates, John W., St. James St., Montreal.

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Babcock & Wilcox, Ltd. Montreal.
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Cole, Ltd., Geo. W., Toronfo.
Garlock Packing Co., Hamilton, Ont.
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Laurie & Lamb, Montreal.

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Babcock & Wilcox, Ltd. Montreal.
Cole, Ltd., Geo. W., Toronto.
Goldie & McCulloch Co., Galt.
Frick Co., Waynesboro, Franklin Co., Pa.
Inglis Co., The John, Toronto, Ont.
Jenckes Macbine Co., Sherbrooke, Que.
Jones Underfeed Stoker Co., Toronto.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Ladd, The Geo. T., Co., Pittsburgb, Pa.
McAvity, T., & Sons, Ltd., St. John, N.B.
Waterous Engine Works Co., Brantford, Ont.

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Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Jenckes Machine Co., Sherbrooke, Que.
John McDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford, Ont.

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MacLean Publishing Co., Toronto.

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D'Este Co., Julian, Boston, Mass.

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Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.

BRINE TANKS
Frick Co., Waynesboro, Franklin Co., Pa.
Waterous Engine Works Co., Brantford, Ont.
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Steel Mill Packing Co., Windsor, Ont.

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Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.

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Jas. Morrison Brass Mfg. Co., Toronto.

CAST IRON FITTINGS
Lunkenheimer Co., Cincinnati, O.
McAvity, T., & Sons, Ltd., St. John, N.B.

CASTINGS, BRASS AND IRON
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Lunkenheimer Co., Cincinnati, O.
John McDougall Caledonian Iron Works Co., Ltd., Montreal.
McAvity, T., & Sons, Ltd., St. John, N.B.
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Beveridge Paper Co., Montreal.
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Ed. Bennis & Co., Little Hulton, Bolton, Eng.
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MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford, Ont.

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Can. Allis-Chalmers, Ltd., Toronto, Ont.

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Bawden Machine Co., Toronto.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
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Frick Co., Waynesboro, Franklin Co., Pa.
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Sturtevant Co. of Canada, B. F., Galt, Ont.

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Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.

INSULATORS
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Beveridge Paper Co., Ltd., Montreal, Que.

IRON FILLER
Can. H. W. Johns-Manville Co., Toronto, Ont.

LACE LEATHERS
Graton & Knight Mfg. Co., Montreal.

LAMPS, ARC
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.

LAMPS, INCANDESCENT
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, NITRO
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LAMPS, TUNGSTEN AND NITRO
Can. General Electric Co., Toronto, Ont.
Can. Laco-Philips Co., Ltd., Toronto, Ont.

LEATHER STRAPPING
Graton & Knight Mfg. Co., Montreal.

LUBRICANTS
Albany Lubricating Co., New York City.
Canadian Economic Lubricant Co., Montreal.
Jos. Dixon Crucible Co., Jersey City.

LUBRICATORS, CYLINDER
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, FORCE FEED
Can. Detroit Lubricator Co., Walkerville, Ont.
Darling Bros., Montreal.
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

LUBRICATORS, PLAIN
Lunkenheimer Co., Cincinnati, O.
Penberthy Injector Co., Windsor, Ont.

MACHINERY INSULATION
Armstrong Cork & Insulation Co., Montreal, Que.
Beveridge Paper Co., Ltd., Montreal, Que.

MECHANICAL STOKERS
Babcock & Wilcox, Ltd., Montreal.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.

METERS, ELECTRIC
Can. H. W. Johns-Manville Co., Toronto, Ont.

METERS, STEAM
Can. Allis-Chalmers, Ltd., Toronto, Ont.

METERS, WATER
Allen General Supplies, Toronto, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Foxboro Company, Foxboro, Mass.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Precision Instrument Co., Detroit, Mich.

MILL AND MINING MACHINERY
Canadian Fairbanks-Morse Co., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
Goldie & McCulloch Co., Galt.
Waterous Engine Works Co., Brantford.

MOTORS
Canadian Fairbanks-Morse Co., Montreal.
Can. General Electric Co., Toronto, Ont.

OFFICE RAILINGS
Jas. Morrison Brass Mfg. Co., Toronto.

OIL CUPS
Albany Lubricating Co., New York City.
Lunkenheimer Co., Cincinnati, O.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.

OILER, COMPOUND FEEDERS
Lunkenheimer Co., Cincinnati, O.

OILERS, GAUGE
Lunkenheimer Co., Cincinnati, O.

OILERS, MULTIPLE
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.

OIL FILTERS AND CIRCULATING SYSTEMS
Bowser & Co., Inc., S. F., Toronto, Ont.
Darling Bros., Montreal.
Elliott Co., Pittsburgh, Pa.
Jas. Morrison Brass Mfg. Co., Toronto.

OIL SEPARATORS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Liberty Mfg. Co., Pittsburgh.
Jas. Morrison Brass Mfg. Co., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

OILING SYSTEMS
Albany Lubricating Co., New York City.
Bowser & Co., Inc., S. F., Toronto, Ont.
Lunkenheimer Co., Cincinnati, O.

OILS, LUBRICATING
Albany Lubricating Co., New York City.
Can. Economic Lubricant Co., Montreal, Que.
Kellogg & Co., E. H., New York, N.Y.

PACKING ENGINE
Can. Asbestos Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. B. K. Morton Co., Toronto, Montreal.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING FIBRE
Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.

PACKING, HYDRAULIC
Can. Asbestos Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Can. B. K. Morton Co., Toronto, Montreal.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Goodyear Tire & Rubber Co., Toronto.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, METALLIC
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Steel Mill Packing Co., Windsor, Ont.

PACKING, ROD
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Steel Mill Packing Co., Windsor, Ont.
Peerless Rubber Mfg. Co., New York, N.Y.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PACKING, SHEET
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Durabla Manufacturing Co., New York.
Garlock Packing Co., Hamilton, Ont.
Jenkins Bros., Ltd., Montreal.
Peerless Rubber Mfg. Co., New York, N.Y.

PACKING, AMMONIA, STEAM AND WATER
Can. Asbestos Co., Montreal, Que.
Can. B. K. Morton Co., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Greene, Tweed & Co., New York.
Goodyear Tire & Rubber Co., Toronto.
Steel Mill Packing Co., Windsor, Ont.

PACKING, LEATHER
Can. B. K. Morton Co., Toronto, Montreal.
Canuck Supply Co., Ltd., Montreal, Que.
Garlock Packing Co., Hamilton, Ont.
Graton & Knight Mfg. Co., Montreal.
Shell-Bar, Boico Supply, Ltd., Toronto, Ont.

PAINT, DAMP RESISTING
Toch Bros., Toronto, Ont.

PENSTOCKS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.

PILLOW BLOCKS
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Waterous Engine Works Co., Brantford.

PIPE COILS
York Mfg. Co., York, Pa.

PIPE COVERINGS, STEAM, BRINE, AMMONIA AND ICE WATER
Armstrong Cork & Insulation Co., Montreal, Que.

PIPE STEEL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPE VISES AND CUTTERS
Armstrong Mfg. Co., Bridgeport, Conn.

PIPE, GAS
Can. Allis-Chalmers, Ltd., Toronto, Ont.

PIPES, WATER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PIPING AND FITTINGS
Frick Co., Waynesboro, Franklin Co., Pa.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Jas. Morrison Brass Mfg. Co., Toronto.
York Mfg. Co., York, Pa.

PIPING, STEAM
Babcock & Wilcox, Ltd., Montreal.

PLATE WORK
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

PLUG COCKS
Homestead Valve Mfg. Co., Pittsburgh, Pa.

POWER PUMPS
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.
Garlock Packing Co., Hamilton, Ont.
Laurie & Lamb, Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.

POWER, TRANSMISSION MACHINERY
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Goldie & McCulloch Co., Galt.
Jeffrey Manufacturing Co., Montreal.
Jenckes Machine Co., Sherbrooke, Que.
MacGovern & Co., New York.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Morse Chain Co., Ithaca, N.Y.
Waterous Engine Works Co., Brantford.

PRESSES
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.

PRESSURE, BLOWERS, CENTRIFUGAL
Can. Sirocco Co., Windsor, Ont.

PULLEYS
American Pulley Co., Philadelphia, Pa.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Wm. Hamilton Co., Ltd., Peterboro.
Jeffrey Manufacturing Co., Montreal.
Waterous Engine Works Co., Brantford.

PULP MILL MACHINERY
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.

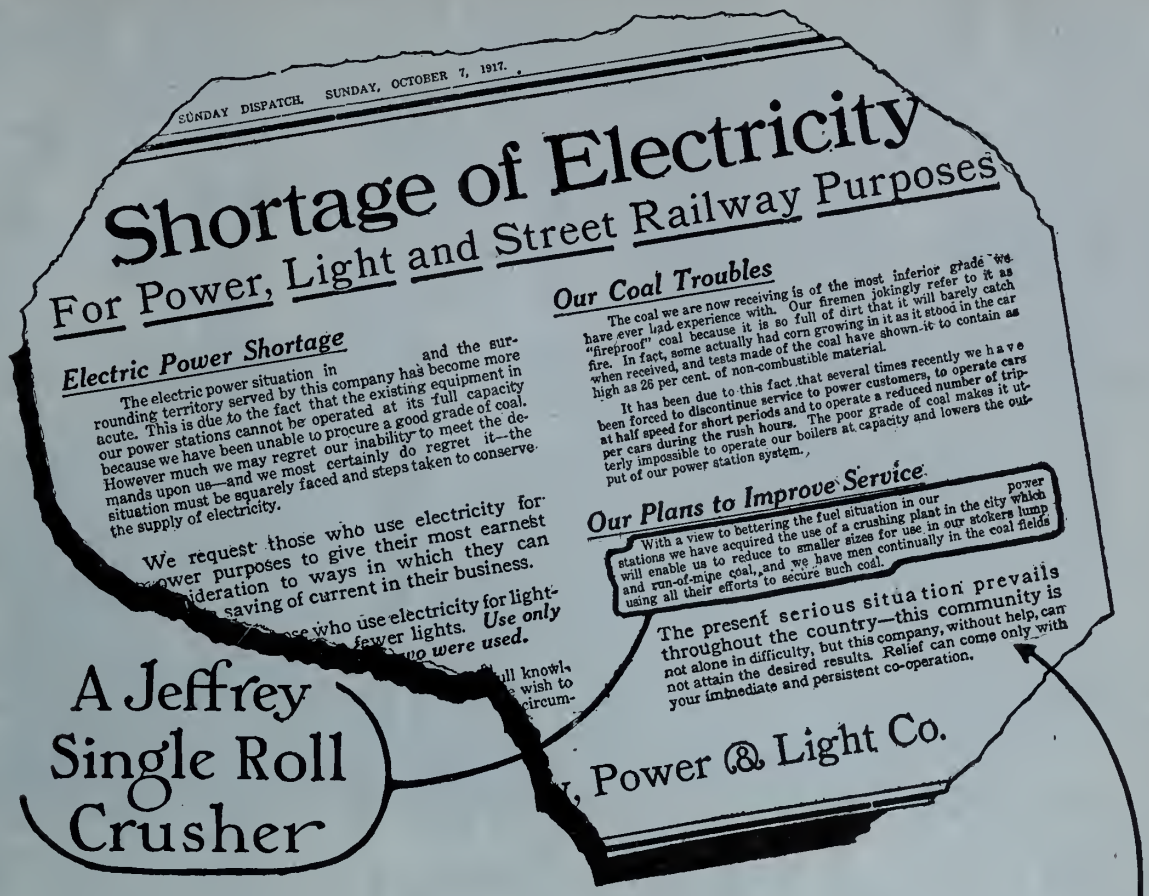
PUMPING MACHINERY
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Bawden Machine Co., Toronto.
Laurie & Lamb, Montreal.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.
Waterous Engine Works Co., Brantford.

PUMPING MACHINERY, ELECTRICAL
Bawden Machine Co., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Jeffrey Manufacturing Co., Montreal.
Storey Pump & Equipment Co., Ltd., Toronto.
Smart-Turner Machine Co., Ltd., Hamilton.

PUMPS, AIR
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co. Ltd., Montreal.
Smart-Turner Machine Co., Ltd., Hamilton.
Storey Pump & Equipment Co., Ltd., Toronto.

PUMPS, CONTRACTORS'
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.

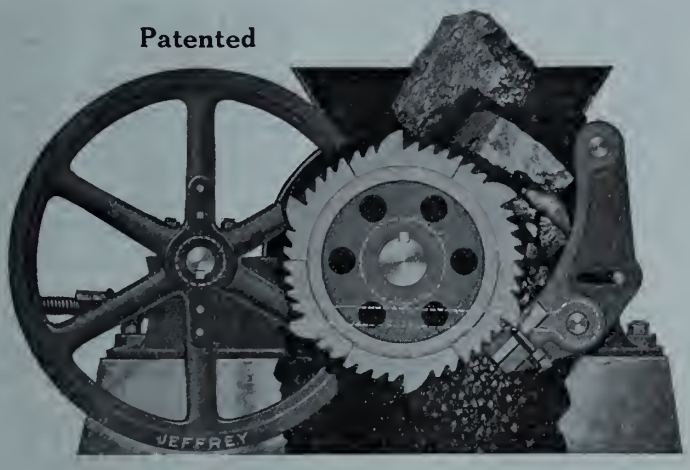
PUMPS, ELECTRICAL
American Steam Pump Co., Battle Creek, Mich.


SUNDAY DISPATCH. SUNDAY, OCTOBER 7, 1917.
Shortage of Electricity
For Power, Light and Street Railway Purposes
Electric Power Shortage
The electric power situation in and the surrounding territory served by this company has become more acute. This is due to the fact that the existing equipment in our power stations cannot be operated at its full capacity because we have been unable to procure a good grade of coal. However much we may regret our inability to meet the demands upon us—and we most certainly do regret it—the situation must be squarely faced and steps taken to conserve the supply of electricity.
We request those who use electricity for power purposes to give their most earnest consideration to ways in which they can saving of current in their business.
who use electricity for lighting fewer lights. Use only were used.
Our Coal Troubles
The coal we are now receiving is of the most inferior grade we have ever had experience with. Our firemen jokingly refer to it as "fireproof" coal because it is so full of dirt that it will barely catch fire. In fact, some actually had corn growing in it as it stood in the car when received, and tests made of the coal have shown it to contain as high as 26 per cent. of non-combustible material.
It has been due to this fact that several times recently we have been forced to discontinue service to power customers, to operate cars at half speed for short periods and to operate a reduced number of trippers during the rush hours. The poor grade of coal makes it utterly impossible to operate our boilers at capacity and lowers the output of our power station system.
Our Plans to Improve Service
With a view to bettering the fuel situation in our power stations we have acquired the use of a crushing plant in the city which will enable us to reduce to smaller sizes for use in our stokers lump and run-of-mine coal, and we have men continually in the coal fields using all their efforts to secure such coal.
The present serious situation prevails throughout the country—this community is not alone in difficulty, but this company, without help, can not attain the desired results. Relief can come only with your immediate and persistent co-operation.
Power & Light Co.
A Jeffrey Single Roll Crusher

Are You Facing a Similar Situation?

If so, why not Crush your Run-of-Mine or Lump Coal right in your own Power House with a

Patented



JEFFREY

SINGLE ROLL

Coal Crusher

One operation reduces Lump or Run-of-Mine Coal to the proper size for maximum heat efficiency in stokers.

Bulletin No. 141-4 fully describes this machine — tells what it has done for others. Send to-day for your copy.

THE JEFFREY MFG. CO.

Canadian Branch and Warerooms, - MONTREAL

Headquarters for Chains and Attachments, Sprockets, Elevators, Buckets, Boots, Casings, Spiral and Belt Conveyer, Gears, Etc.

If any advertisement interests you, tear it out now and place with letters to be answered.

PUMPS, FEED WATER
Can. Allis-Chalmers, Ltd., Toronto, Ont.
PUMP GOVERNORS AND REGULATORS
Bawden Machine Co., Ltd., Toronto.
Darling Bros., Montreal.
G. M. Davis Regulator Co., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Mason Regulator Co., Boston, Mass.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
Watson & McDaniel Co., Philadelphia.
PUMP STRAINERS
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Ltd., Montreal.
Liberty Mfg. Co., Pittsburgh, Pa.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, HAND AND POWER
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, CENTRIFUGAL
American Steam Pump Co., Battle Creek, Mich.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Laurie & Lamb, Montreal.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Pulsometer Engineering Co., Ltd., London, Eng.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Waterous Engine Works Co., Brantford.
PUMPS, DUPLEX
Can. Allis-Chalmers, Ltd., Toronto, Ont.
PUMPS, GEARED, COMPOUND
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Canadian Fairbanks-Morse Co., Ltd., Montreal.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, HYDRAULIC, PRESSURE
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Darling Bros., Montreal.
Inglis Co., The John, Toronto, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
PUMP LEATHERS
Beveridge Paper Co., Ltd., Montreal, Que.
Can. B. K. Morton Co., Toronto, Montreal.
Graton & Knight Mfg. Co., Montreal.
PUMPS, OIL
American Steam Pump Co., Battle Creek, Mich
Bawden Machine Co., Ltd., Toronto.
Bowser & Co., Inc., S. F., Toronto, Ont.
Can. Detroit Lubricator Co., Walkerville, Ont.
Lunkenheimer Co., Cincinnati, O.
McAvity & Sons, T., St. John, N.B.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, STEAM TURBO
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Darling Bros., Montreal.
Escher Wyss & Co., Montreal, Que.
Pulsometer Engineering Co., Ltd., London, Eng.
PUMP TANK, RECEIVER
American Steam Pump Co., Battle Creek, Mich.
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, STEAM
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Goldie & McCulloch Co., Galt.
Inglis Co., The John, Toronto, Ont.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
McAvity & Sons, T., St. John, N.B.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PUMPS, TRIPLEX
Smart-Turner Machine Co., Hamilton, Ont.
PUMPS, VACUUM
American Steam Pump Co., Battle Creek, Mich.
Bawden Machine Co., Ltd., Toronto.
Laurie & Lamb, Montreal.
Leitch Co., Arthur S., Toronto, Ont.
The John McDougall Caledonian Iron Works Co., Ltd., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Storey Pump & Equipment Co., Ltd., Toronto.
PYROMETERS
Foxboro Co., The, Foxboro, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
Taylor Instrument Co., Rochester, N.Y.
Uehling Instrument Co., New York, N.Y.
RADIATOR TRAPS
Sarco Co., Inc., New York, N.Y.
RADIATOR AIR VENTS
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor, Ont.
REBOILERS
Frick Co., Waynesboro, Franklin Co., Pa.
York Manufacturing Co., York, Pa.
RECEIVERS, AIR
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
RECORDING INSTRUMENTS
Can. H. W. Johns-Manville Co., Toronto, Ont.
Foxboro Co., The, Foxboro, Mass.
Precision Instrument Co., Detroit, Mich.
Uehling Instrument Co., New York, N.Y.

REFRIGERATOR DOORS, WINDOWS, ETC.
Jamison Cold Storage Door Co., Hagerstown, Md.
REFRIGERATING MACHINERY
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Griscom-Russell Co., Ltd., Montreal.
Frick Co., Waynesboro, Franklin Co., Pa.
Linde Canadian Refrigeration Co., Montreal.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.
REFUSE DESTRUCTOR
Canadian Griscom-Russell Co., Ltd., Montreal.
Laurie & Lamb, Montreal.
REGULATORS, PRESSURE
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
D'Este Co., Julian, Boston, Mass.
Jas. Morrison Brass Mfg. Co., Toronto.
REGULATORS, TEMPERATURE
Sarco Co., Inc., New York, N.Y.
RETORTS
MacKinnon, Holmes & Co., Sherbrooke, Que.
REVOVLING DOORS FOR HARDENING ROOMS
Jamison Cold Storage Door Co., Hagerstown, Md.
ROPE PRESERVATIVE
Cling Surface Co., Buffalo.
ROTARY CONVERTERS
Canadian Fairbanks-Morse Co., Montreal.
RUBBER HOSE
Can. H. W. Johns-Manville Co., Toronto, Ont.
Garlock Packing Co., Hamilton, Ont.
Liberty Mfg. Co., Pittsburg, Pa.
RUBBER MOLDS
Bawden Machine Co., Ltd., Toronto.
SAFES
Canadian Fairbanks-Morse Co., Montreal.
Goldie & McCulloch Co., Galt.
SCALE REMOVERS
Babcock & Wilcox, Ltd., Montreal.
Beveridge Paper Co., Ltd., Montreal, Que.
Can. H. W. Johns-Manville Co., Toronto, Oot.
William B. Pierce Co., Buffalo, N.Y.
SEAM PROTECTORS, GIRTH
National Boiler Protector Co. of Canada, Montreal, Que.
SHAFTING
Can. Bond Hanger & Coupling Co., Alexandria, Ont.
Goldie & McCulloch Co., Galt.
Jenckes Machine Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SHAKING AND DUMPING GRATES
Babcock & Wilcox, Ltd., Montreal.
Galt Foundry Co., Galt, Ont.
Waterous Engine Works Co., Brantford.
SMOKE BOXES, STACKS
Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
MacKinnon, Holmes & Co., Sherbrooke, Que.
Waterous Engine Works Co., Brantford.
SPECIAL MACHINERY
Bawden Machine Co., Ltd., Toronto.
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Smart-Turner Machine Co., Hamilton, Ont.
Waterous Engine Works Co., Brantford.
SPEED INDICATORS
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenburg Mfg. Co., Brooklyn, N.Y.
L. S. Starrett Co., Athol, Mass.
SPLICE PROTECTORS
Jordan Bros., Inc., New York, N.Y.
SPROCKET CHAIN ATTACHMENTS
Waterous Engine Works Co., Brantford.
SPROCKET RIMS
Babbitt Steam Specialty Co., New Bedford, Mass.
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Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Waterous Engine Works Co., Brantford.
STACKS, STEEL
Babcock & Wilcox, Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
STAND PIPES, STEEL
MacKinnon, Holmes & Co., Sherbrooke, Que.
STAYBOLTS, FLEXIBLE
Can. Allis-Chalmers, Ltd., Toronto, Ont.
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Babcock & Wilcox, Ltd., Montreal.
Can. Allis-Chalmers, Ltd., Toronto, Ont.
Canadian Fairbanks-Morse Co., Montreal.
Darling Bros., Montreal.
Direct Separator Co., Syracuse, N.Y.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
Leitch Co., Arthur S., Toronto, Ont.
Penberthy Injector Co., Windsor, Ont.
Smart-Turner Machine Co., Hamilton, Ont.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Watson & McDaniel Co., Philadelphia.
STEAM SPECIALTIES
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Canadian Fairbanks-Morse Co., Montreal.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
D'Este Co., Julian, Boston, Mass.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Mason Regulator & Engineering Co., Montreal.
Jas. Morrison Brass Mfg. Co., Toronto.
Penberthy Injector Co., Windsor.
Watson & McDaniel Co., Philadelphia.
STEAM TRAPS
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Anderson Co., Y. D., Cleveland, O.
Canadian Fairbanks-Morse Co., Montreal.
Can. Sirocco Co., Windsor, Ont.
Cole, Ltd., Geo. W., Toronto.
Darling Bros., Montreal.
Davis Regulator Co., G. M., Chicago.
D'Este Co., Julian, Boston, Mass.
Elliott Co., Pittsburgh, Pa.
J. T. Long, 84 Adam St., Montreal, Que.
Can. Morehead Mfg. Co., Woodstock.
Mason Regulator & Engineering Co., Montreal.
Nashua Mach. Co., Boston, Mass.
Sarco Co., Inc., New York, N.Y.
Sturtevant Co. of Canada, B. F., Galt, Ont.
Watson & McDaniel Co., Philadelphia.
STEEL BARRELS
Smart-Turner Machine Co., Hamilton, Ont.
STEEL DRUMS
Smart-Turner Machine Co., Hamilton, Ont.
STEEL TANKS
Babcock & Wilcox, Ltd., Montreal.
MacKinnon, Holmes & Co., Sherbrooke, Que.
STOKERS
Babcock & Wilcox, Ltd., Montreal.
Ed. Bennis & Co., Little Fulton, Bolton, Eng.
Detroit Stoker Co., Detroit, Mich.
Galt Foundry Co., Galt, Ont.
Jones Underfeed Stoker Co., Toronto.
Murphy Iron Works, Dertoit, Mich.
STRAINERS
Babcock & Wilcox, Ltd., Montreal.
Bawden Machine Co., Ltd., Toronto.
Elliott Co., Pittsburgh, Pa.
Self-Cleansing Strainer Co., Chicago.
STRUCTURAL STEEL WORK
Babcock & Wilcox, Ltd., Montreal.
MacKinnon, Holmes & Co., Ltd., Sherbrooke, Que.
SUPERHEATERS, STEAM
Babcock & Wilcox, Ltd., Montreal.
SWITCHBOARDS
Can. General Electric Co., Toronto, Ont.
SWITCHES AND SWITCH BOXES
Can. H. W. Johns-Manville Co., Toronto, Ont.
TACHOMETERS
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont.
Can. H. W. Johns-Manville Co., Toronto, Ont.
Foxboro Co., The, Foxboro, Mass.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N.Y.
TANKS, BLOW-OFF
Darling Bros., Montreal.
John McDougall Caledonian Iron Works, Montreal.
Waterous Engine Works Co., Brantford.
TANKS, FREEZING, STORAGE AND WATER COOLING
Frick Co., Waynesboro, Franklin Co., Pa.
TANKS, OIL
Boving Hydraulic & Eng. Co., Ltd., Lindsay, Ont
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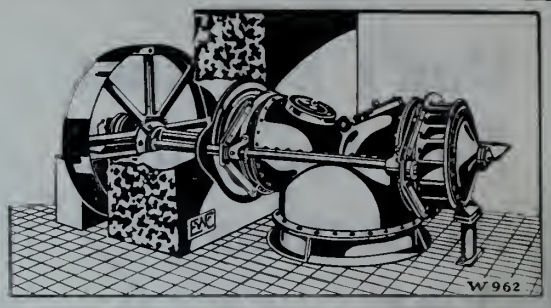

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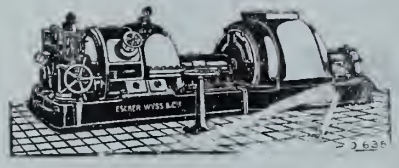

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62-17

INDEX TO ADVERTISERS

PAGE

A

Albany Lubricating Co. 71
Alberger Heater Co. 52
Allen General Supplies, Ltd.... 63
American Steam Gauge & Valve Mfg. Co. 50
American Steam Pump Co..... 70
Anderson Co., V. D. 81
Armstrong Cork Insulation Co. 11
Audel & Co., Theo 85

B

Babbitt Steam Specialty Co.... 71
Babcock & Wilcox 78
Bennis & Co., Ltd., Ed..... 4
Beveridge Paper Co. 86
Boiler Inspection Dept. 77
Boving Hydraulic & Eng. Co.. 76
Bowser, S. F., & Co., Inc..... 62

C

Can. Assoc. Stationary Engrs.. 68
Can. Bond Hanger & Coupling Co. 74
Can. Detroit Lub. Co. 74
Can. Fairbanks-Morse Co. 49
Can. General Electric Co..... 15
Can. H. W. Johns-Manville Co., Ltd. 9
Can. Laco-Philips Co. 66, 67
Can. Morehead Mfg. Co. 81
Can. S K F Co. 53
Canuck Supply Co., Ltd..... 73
Chaplin-Fulton Co. 64
Cling-Surface Co. 71
Cole, Geo. W. 47
Coppus Eng. & Equip. Co.... 6

D

Darling Bros. 62
Dart Union Co. 61
Davis Regulator Co. 64
D'Este Co., Julian 87
Direct Separator Co. 54
Dixon Crucible Co., Jos. 48
Dominion Belting Co. 70
Dominion Coal Co. 76
Durabla Mfg. Co. 50

E

Economy Fuse & Mfg. Co. of Canada 4
Elliott Company 45
Escher Wyss & Co. 88

F

Federal Engineering Co. 81
Francis, Walter J., & Co..... 48
Frick Co. 11

G

Galt Foundry Co. 5
Garlock Packing Co. 72
Garth Co. 76
Gates, John W. 46
Goldie & McCulloch Co. 16
Goodyear Tire & Rubber Co... 8
Graton & Knight Mfg. Co..... 55
Greene, Tweed & Co. 51

H

Holmes Metallic Packing Co... 76
Homestead Valve Mfg. Co. ... 87
Hoyt Metal Co. 2

I

Inglis Co., John...Inside back cover

J

Jamison Cold Storage Door Co. 12
Jefferson Union Co. 65
Jeffrey Mfg. Co. 83
Jenckes Machine Co. 2
Jenkins Bros. 57
Jones Underfeed Stoker Co., Ltd. 44
Jordan Bros., Inc. 77

K

Kellogg & Co., E. H. 48
Kerr Engine Co. 60

L

Ladd Co., The Geo. T. 76
Laurie & Lamb 13
Leitch Co., The Arthur S..... 6
Linde Canadian Refrigeration Works Co. 10
Long, J. T. 46
Lunkenheimer Co. 5

M

MacGovern & Co. 87
MacKinnon, Holmes & Co..... 48
MacLean's Magazine 58
Magnolia Metal Co. 74
Mason Regulator Co. 6
Mason Regulator & Eng. Co., Ltd. 7
McAvity & Sons, T. 67
McDougall Caledonian Iron Works Co. 14
McGhie, W. C. 76
McLaren, D. K., Ltd. 69
Merchants Rubber Fdy. 47
Morrison Brass Mfg. Co., Jas. Outside back cover
Morse Chain Co. 75
Murphy Iron Works 3

N

National Boiler Seam Protector Co. 59

P

Peerless Rubber Co. ..... Inside front cover
Penberthy Injector Co., Ltd... Front cover
Pennsylvania Flexible Metallic Tubing Co. 54
Power Plant Equipment Co... 60
Pratt & Cady Co. 52

S

Sarco Co., Inc. 47
Scaife, Wm. B., & Sons Co... 86
Schaeffer & Budenberg Mfg. Co. 6
Shell-Bar, Boico Supply, Ltd... 3
Smart-Turner Mach. Co. 77
Starrett, L. S., Co. 78
Steel Mill Packing Co. 5

T

Toch Bros. 64
Trimont Manufacturing Co. .. 78

U

Uehling Instrument Co. 60

V

Vilter Mfg. Co. 10

W

Wall, W. J. 48
Waterous Engine Works Co... 1
Watson & McDaniel Co. 76
Williams & Co., J. H. 77

Y

York Mfg. Co. 12

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